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HEATING.

The Commissioners of His Majesty's Works, &c., are prepared to receive TENDERS before 11 a.m. on Tuesday, 4th October, 1932, for ACCELERATED LOW-PRESSURE HOT WATER HEATING at the Employment Exchange, Charles-street, Leicester.

Drawings, specification, a copy of the conditions and form of contract, bills of quantities and forms for Tender may be obtained from the CONTRACTS BRANCH, H.M. Office of Works, King Charles-street, London, S.W.1, on payment of One Pound. (Cheques payable to the Commissioners, H.M. Office of Works.) The sums so paid will be returned to those persons who send in Tenders in conformity with the conditions. 8953

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Particulars of the proposed Amendment were set forth in No. 2278 of the Official Journal (Patents), published on 14th September, 1932.

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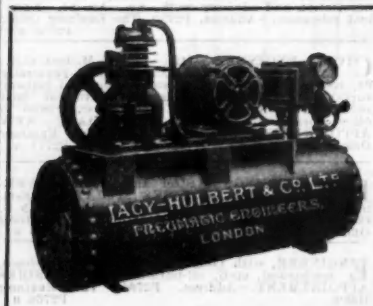

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The Engineer.

WE trust we may be forgiven for the little touch of vanity if we remind our readers that with the present number THE ENGINEER begins its fifth millennial of issues. This paper was first published on January 4th, 1856, and week by week, with one unavoidable break, it has appeared regularly for nearly seventy-seven years. The break was that caused by the great strike of 1926, when, like practically all other newspapers, we had to suspend publication for two weeks—May 7th and 14th. But when the paper appeared again the sequence of numbers was restored, so that although two weeks are missing, the numbers follow without interruption. We have no recollection of another break of a week or even of a whole day, and but rarely has the delivery been delayed by as little as an hour. Sometimes we find ourselves wondering if the present economic and industrial troubles might not be traced back to the strike of 1926, and the dislocation of markets, as well as industries, that it caused. However, the country is now beginning to recover and the support which the engineering and allied industries have given to this old, but ever young, paper during the depression gives us reason to believe that some twenty years hence, THE ENGINEER will be able to record the completion of another thousand numbers and start upon its sixth millennial unimpaired in vigour.

Coal Production.

IT is encouraging to find from an examination of the coal production returns for the first half of 1932, now completed by the addition of figures from Poland, that proportionately Britain's coal exports have declined less than those of other countries. The figures indicate that the exports from this country at 19,823,000 tons were 7 per cent. less than those for the corresponding period last year. Germany exported 8,802,000 tons, a reduction of 26 per cent., and the Polish returns show an approximately equal proportionate reduction on an output of 4,569,000 tons. The United States industry was only able to export 66 per cent. of the quantity sent out of the country in 1931. An interesting feature revealed by the figures is that while Polish and German exports to the Baltic and Scandinavia declined heavily by 770,000 tons and 44,000 tons respectively, this country's deliveries to that area increased by 584,000 tons. South America, among countries outside Europe, took 139,000 tons of coal more than last year from Britain, and in spite of a considerable reduction in the total imports of that fuel, the Canadian market took a greater quantity from this country.

Harland and Wolff, Ltd.

THE report of Harland and Wolff, Ltd., for the year ended 1931 shows that owing to the depression in the shipbuilding and ship-repairing trades the company has sustained a loss which, without provision for depreciation, amounts to £283,137. After crediting an amount transferred from a provision for contingencies no longer required, dividends from investments, and the amount brought forward from 1930, only the small balance of £7136 remains at the credit of the profit and loss. The work done has been so much below that of previous years that only a small part of the company's shipbuilding and engineering facilities has been usefully employed. Drastic reduction in both directors' and staff remuneration has been made. The report gives details of the Royal Mail reorganisation scheme as it affects the company, and it is pointed out that under the moratorium granted under this scheme, and with prevailing conditions in the industry, no reliable estimates of liabilities, the value of assets, or the earning capacity of the company can be made, which must be done before any scheme for the reorganisation of share capital can be considered. No action in this direction is therefore suggested at present. Although conditions are admittedly difficult, the company's prospects as shipbuilders and engineers should, it is claimed, be equal to any in the industry, both as regards its capacity to build economical ships for any service, and its increasing scope of engineering activities, the organisation being well prepared to take advantage of any improvement or revival in trade.

Coastal Shipping Trade.

A MOVEMENT has been set on foot by Members of Parliament, representing ports and shipping interests, to draw attention to the necessity of expanding our coastal shipping trade. A statement recently issued by its sponsors draws attention to the danger of thinking of our national transport solely in terms of road and rail traffic, and overlooking the importance of our coastal shipping lines. It points out that almost every argument that can be adduced in favour of protecting the railways from unfair competition can be urged and reinforced on behalf of the coasting trade. The average number of coastal vessels in commission is roughly 2375, with a total tonnage of 1,176,629, capital exceeds £15,000,000, and the industry affords employment on board its vessels for more than 26,000 men, as well as for tens of thousands at the docks and harbours of the various coastal ports. The great manufacturing centres of this country are mainly within easy distance of the coast, and our seaboard, now as throughout history, offers great advantages of cheap transport for internal trade and transhipment. These facts, it is held, surely may be regarded as splendid reasons for the development of our coastal routes, the rehabilitation of those of our neglected ports that are worth saving, and the equipment of Great Britain for future trade triumphs.

The State and the New Cunarder.

IN the course of a speech made at Dunblane on Saturday last, September 10th, Sir Robert Horne made the suggestion that by the wise use of Government credit a great deal of employment could be given on the Clyde by the resumption of work on the new Cunarder at Clydebank. Not merely would actual employment be given to those men engaged on the ship itself, but also work would be provided in the many trades which are represented by the fittings and equipment of a large passenger liner. We used to be looked upon, Sir Robert went on to say, as the greatest shipowning nation in the world, and the holder of the Blue Riband of the Atlantic, but we no longer hold pride of place of that kind, and are coming to be regarded as a second-class shipping Power on the Atlantic route. That was bad, both in its immediate results and in the lowering of our prestige, which robbed us of many contracts which otherwise would come to this country. Sir Robert Horne holds that a little timely help in the building of the ship would not only cost the country nothing, but it would give immense advantages in employment, and enable us to retrieve the old prestige. A precedent had been created in the case of the Cunard Line ships "Lusitania" and "Mauretania," many years ago, and the exceptional circumstances of the present time justified, in his view, exceptional measures. It is understood that informal talks have taken place between Sir Thomas Royden, a director of the Cunard Company, Mr. Neville Chamberlain, Chancellor of the Exchequer, and Mr. Walter Runciman, President of the Board of Trade, with regard to the possibility of resuming work on the new Cunarder. It is further understood that the Cunard Steam Ship Company, Ltd., has invited the Government to guarantee a loan of £8,000,000 for the building of two ships, the first of which could be ready for her maiden voyage within two years if work were restarted at once.

Room Temperature Measurement.

FOR some years past the Department of Scientific and Industrial Research has been studying the efficiency of buildings from the standpoint of the user, a study which has included problems connected with the heating, ventilation, and acoustics of rooms and buildings. In the course of these investigations, the need for a new criterion of the thermal comfort of an environment, which can be expressed not in physiological sensations, but in physical quantities capable of exact measurement, has been felt. Such a criterion, under the name of equivalent temperature, has been put forward by Mr. A. F. Dufton, of the Building Research Station, and is described in a pamphlet entitled "The Equivalent Temperature of a Room and its Measurement." The scale of equivalent temperature is essentially a refinement of the sensation scale. It is based upon the rate of loss of heat from a heated body, and the equivalent temperature of an environment has been defined "as that temperature of a uniform enclosure in which, in still air, a sizable black body at 75 deg. Fah. loses heat in the same ratio as in the environment." The report to which we refer discusses the definition of a scale of equivalent temperature and gives a full description of the instrument designed by Mr. Dufton to record it, which has been named the Eupathescope. Arrangements have been made, we understand, for this instrument to be manufactured and placed on the market by the Cambridge Instrument Company, Ltd.

Waterloo Bridge.

WHEN the London County Council assembles on October 18th, an important recommendation is likely to be made by the Improvements Committee, with regard to the temporary treatment of Waterloo Bridge. Several plans have been considered by the Committee, having as their objects the placing of the structure in a satisfactory condition to withstand the traffic, until such times come as financial conditions may permit the consideration of a new and complete scheme of reconstruction. The plan which is likely to be adopted, we are given to understand, is one for replacing the faulty arches and sinking piers with a steel structure, specially designed to prevent further subsidence. This plan, if adopted, will also enable the stones of the bridge which may be replaced, to be stored in readiness for an eventual rebuilding of the bridge should at a later date such a course be adopted. The temporary reconstruction scheme under consideration would not, it is understood, permanently destroy the present character of the bridge, while the cost of executing the plan would probably be less than £100,000. The expenditure of a sum of this order would most likely obviate the necessity for a further large expenditure for several years to come.

Stone Decay in Westminster Hall.

IN the Annual Report of the Building Research Board for 1931, just issued, reference is made to the decay which has occurred in Ketton stone used about 1880 for the restoration of the interior of the west wall of Westminster Hall, which has been found to be associated with the presence of chlorides. Records have now been found of excavations made some years ago to examine the foundations and subsoil. As these records show that the foundation of the west wall rests on water-logged sand, there would appear to be little room for doubt that the chlorides have been derived from brackish Thames water which has been absorbed through the subsoil. The localisation of the decayed areas is thought to be due to differences in the degree of contact between the Ketton stone facing and the rubble core. An attempt is being made to determine whether measurable variations in the moisture content of the wall accompany fluctuations in the tidal level of the river.

Air Flow Through an Airscrew.

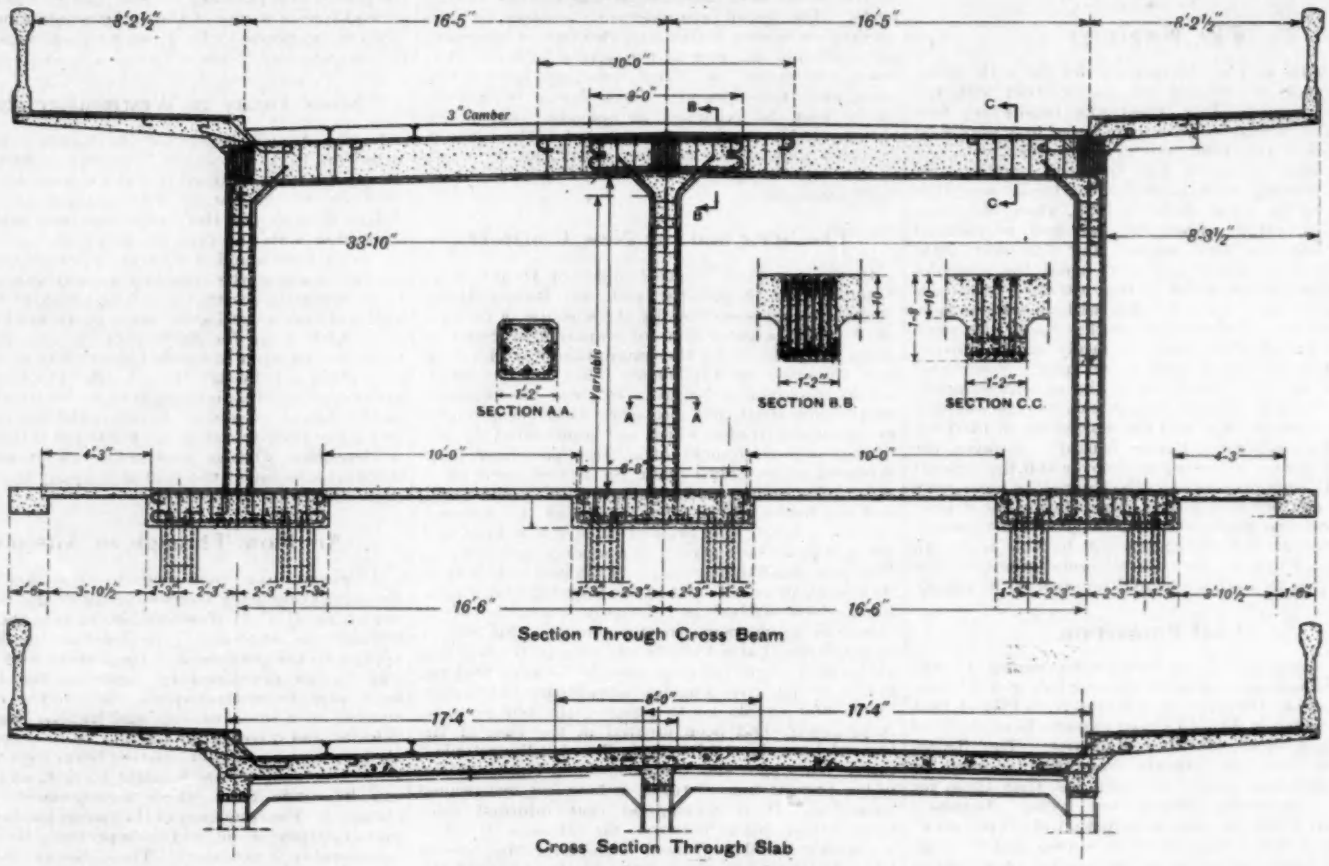
A PAPER just published by the Aeronautical Research Committee describes an investigation carried out by Mr. H. C. H. Townend, B.Sc., into the air flow through an airscrew. The hot-wire method was applied to the periodic flow through an airscrew and was further developed by replacing the hot wire by a periodic electric spark, the shadow of which consists of a series of dots and thereby enables the velocity and direction of the flow to be mapped out. By interrupting the illuminating beam with a stroboscope the shadows are brought to rest, and records can be made from which measurements can be obtained. The frequency of the sparks has been taken up to 1300 per second, and could probably be increased considerably if necessary. Their shadows have been observed with ease up to a wind speed of 30ft. per second. By interrupting the illuminating beam of light with a stroboscope driven by the screw, and by changing the phase relations between them, the motions of individual small masses of air could be observed at any point in the field. Arrangements were made to change the phase relation between the screw and the spark generator, while the stroboscope remained synchronised with the latter. The general motion of the dots downstream was thereby arrested, while the deviations produced by the screw were revealed. The making of shadowgraphs was facilitated by using a differential stroboscope arranged to give isolated exposures of about 1/6000 second every hundred revolutions of the screw. We understand that a more complete examination of the flow round an airscrew is to be made, using a larger and more accurate screw mounted in a proper wind tunnel.

Salesmanship.

AT the opening meeting of the National Association for Salesmanship, which was held at the Hotel Victoria, London, on Wednesday evening last, September 14th, Sir Francis Goodenough took the chair, and was elected the first President of the Association. Sir Francis announced that the new Association would be conducted by and as an offshoot of the Incorporated Sales Managers' Association. Membership in it would be open to all young men and women over eighteen years of age who were engaged in the vocation of selling and desired to qualify for promotion and become sales managers. In order to attain the aims and objects for which the Association had been formed, Sir Francis continued, a regular series of addresses and discussions of interest to those engaged in selling had been arranged. A library and reading room had been provided, and an employment bureau and benevolent fund established. Arrangements would also be made eventually for the examination of those desirous of becoming members and the awarding of certificates to successful candidates. Continuing, Sir Francis said :—"The business world at large has been all too slow in recognising the fundamental importance to industry (and therefore to the material well-being of the nation) of those whose work is to secure and retain customers for the products of industry. The status and rewards which should be given to them have only as yet been conceded by a minority of business houses, all of whom, however, are to be found in the front rank of progress and success. Equally slow has the business world been in appreciating the need for carefully selected, well-educated, and efficiently trained *personnel* throughout the commercial organisation of every firm. Up to now, the best brains engaged in industry and commerce in this country, with striking exceptions too few to affect the argument, have been concentrated on the problems of production and finance to such a degree as to prevent adequate attention being given to the problems of marketing, on which the continuance of production and the success of finance depend."

CONCRETE WORK OF THE BANGKOK BRIDGE

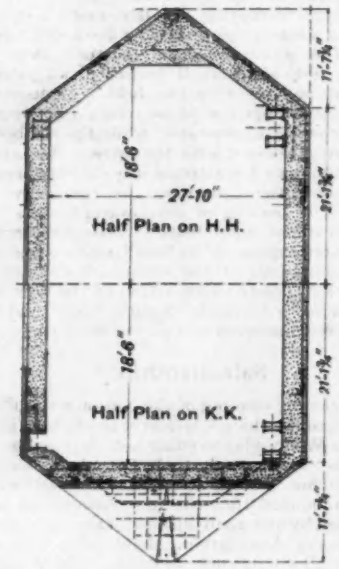
(For description see opposite page.)

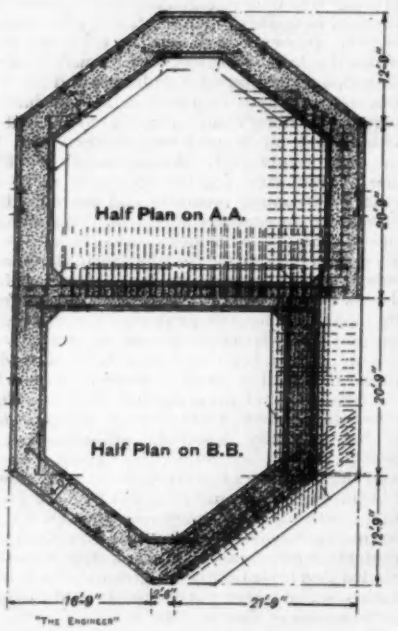


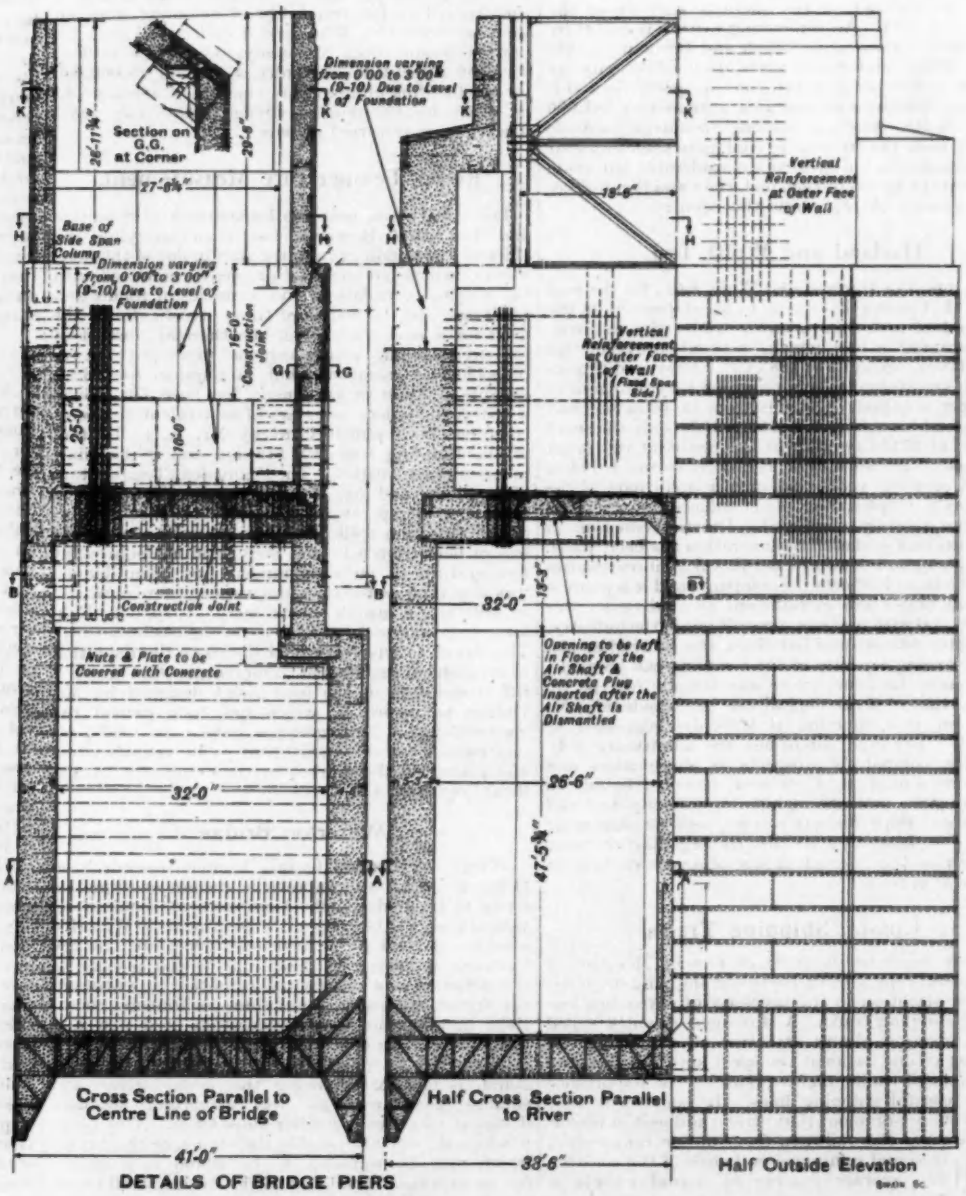
Section Through Cross Beam

Cross Section Through Slab

DETAILS OF EAST APPROACH VIADUCTS






Section on G.G. at Corner
Dimension varying from 0'00 to 3'00" (9-10) Due to Level of Foundation
Base of Side Span Column
Dimension varying from 0'00 to 3'00" (9-10) Due to Level of Foundation
Construction Joint
Construction Joint
Nuts & Plate to be Covered with Concrete
Vertical Reinforcement at Outer Face of Wall
Vertical Reinforcement at Outer Face of Wall (Fixed Span Side)
32'-0"
Opening to be left in Floor for the Air Shaft & Concrete Plug Inserted after the Air Shaft is Dismantled
32'-0"
26'-6"
Cross Section Parallel to Centre Line of Bridge
Half Cross Section Parallel to River
41'-0"
33'-6"
Half Outside Elevation

DETAILS OF BRIDGE PIERS

"THE ENGINEER"

Bangkok Bridge.

No. II. (*conclusion*).*

River Piers.—The East and West river piers are founded 98ft. below mean water level and penetrate approximately 45ft. and 30ft. into the river bed respectively, both piers being founded on blue clay.

The piers are constructed as hollow reinforced concrete shafts founded on steel caissons filled with mass concrete. They were sunk by the pneumatic process from floating plant moored in the river. The maximum air pressure required during sinking was 45 lb. per square inch. The general construction of the piers is shown in the drawings reproduced on the opposite page, while an engraving on page 282, Fig. 7, shows work in progress on the sinking of one of them. At the cutting edge the steel caissons measure 67ft. long by 41ft. wide. The working chambers were 8ft. high from cutting edge level. Two air shafts and locks were provided. The piers are tapered at the up and downstream ends. A solid concrete slab 5ft. thick covers the roof of the working chamber and encases the steel roof girders. Above this level two large voids are formed in the pier, divided by a central cross wall. The external walls are 4ft. 6in. thick; 20ft. below mean water level the voids are roofed over by a heavily reinforced concrete slab 3ft. thick. Above this slab the central cross wall is omitted and the space inside the pier utilised to form a watertight counterweight chamber. Concrete bases are provided for the steel work supporting the bascule trunnions and approach span bearings. The spaces at the up and downstream ends of the pier are utilised to accommodate the resistances and contactor gear for the bascule span. Permanent steel shell plating was provided for the sides of the piers up to low-water level. To accommodate the varying reactions from the bascule and fixed spans, the tops of the piers are placed excentrically upon the bases so as to improve the distribution of load upon the foundations. There is thus a step 5ft. wide on the river side of each pier. A scarcement varying from 9in. to 1ft. 9in. wide is provided near low-water level to allow for errors in pitching the caissons. The average pressure on the foundation allowing for the effect of buoyancy does not exceed 2¼ tons per square foot, and effect of wind and excentricity of loading does not increase the pressure above 2¾ tons per square foot.

Abutments.—The abutments are founded upon groups of fifty-three 17in. diameter Vibro piles 56ft. 6in. long, reinforced with six ¾in. diameter steel rods. The piles are capped with reinforced concrete slabs 4ft. thick, measuring 54ft. by 16ft., upon which the abutment walls are built up in mass concrete. The abutment itself takes the form of pilasters approximately 8ft. square under the end bearings of the approach spans connected by a wall approximately 5ft. thick upon which the ends of the approach viaducts are supported.

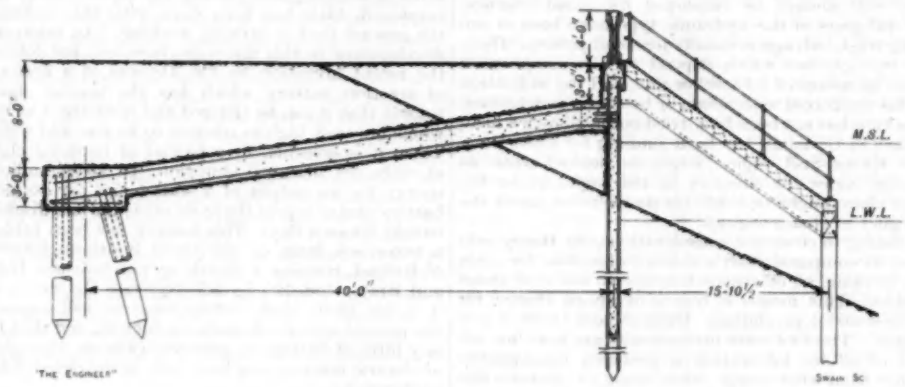


FIG. 4—SECTION THROUGH RIVER WALL

BRIDGE APPROACHES.

The portion of the approach adjacent to the abutments on both sides of the river consists of a reinforced concrete viaduct supported upon 17in. diameter Vibro piles 56ft. long. The viaduct consists of bents of three columns spaced at 16ft. 6in. centre to centre, the spacing between bents being 15ft. Each column is supported by two Vibro piles, capped with a small reinforced concrete slab. The whole area between the pile caps is covered with a 4in. reinforced concrete slab. The columns are connected transversely and longitudinally by reinforced concrete beams supporting the 10in. deck slab. The footway brackets are cantilevered out beyond the outer rows of columns and support reinforced concrete balustrades. Cross-sectional arrangements can be seen on the opposite page. The viaduct extends backwards for a distance of 257ft. behind the abutment centre line on the West approach, and for approximately 177ft. measured parallel to the bridge centre line on the East approach. The viaduct on the East approach is in the form of a U of 139ft. radius connected to the end of the approach span at its apex by a reinforced concrete deck supported on columns of similar construction to the remainder of the viaduct.

From the shore ends of the viaducts on both river banks the approach roads are carried down to ground level upon earth filling supported by concrete retaining walls. The total length of the East approach is 534ft. 9in., and of the West approach 567ft. 9in., measured backwards from the face of the river wall.

River Wall and Stairways.—For a length of approximately 197ft. on either side of the bridge centre line both river banks are protected by a reinforced concrete sheet pile retaining wall anchored back at intervals of 18ft. to clusters of three 17in. diameter Vibro anchor piles situated 40ft. behind the face of the wall. Two piles in each cluster of anchor piles are driven on a rake of 1ft. 4in. The wall itself consists of precast piles 12in. by 16in., 29ft. 6in. long. Every sixth pile acts as a king pile and is made 58ft. long. Piles are keyed together by 1¼in. bore gas tubes inserted in grooves between them. Each pile is attached by steel stirrups to a reinforced concrete beam cast along the back of the wall in which the ends of the anchorages are embedded. The arrangement is shown in the line engraving, Fig. 4. Openings are provided in each wall at two points for stairways, giving access to the water for small boats and at two further points for gangways giving access to floating landing stages. The ends of the walls are returned for a length of 10ft. as a protection against scouring behind the walls. The tops of the sheet piles are capped with a reinforced concrete coping carrying a moulded concrete balustrade.

Pontoon Landing Stages.—Two floating landing stages, consisting of steel pontoons approximately 33ft. by 16ft., are provided on each side of the river. The pontoons are guided between dolphins of three reinforced concrete piles at each end, and are approached by steel bridges, approximately 57ft. long, pivoted to accommodate the rise and fall of the river. The pontoons and their approach bridges are decked with timber.

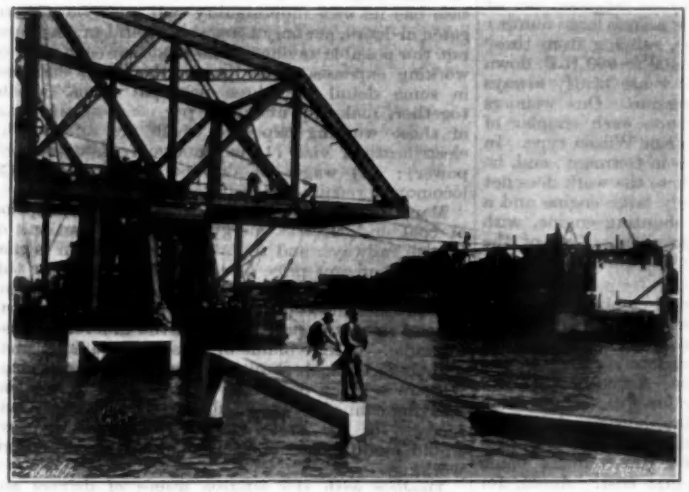
ERECTION PROCEDURE.

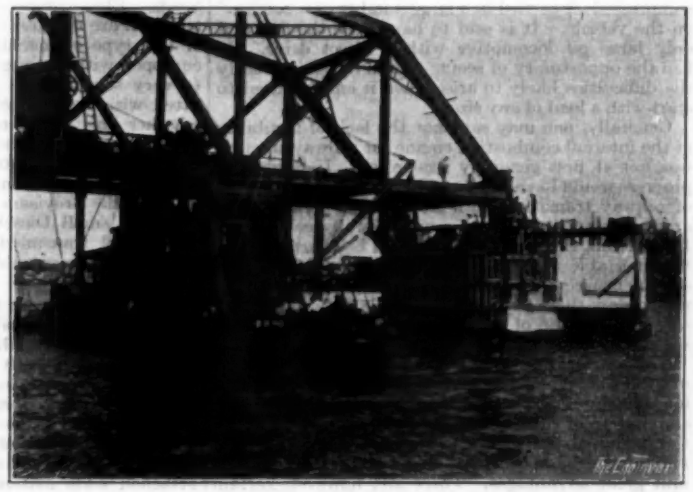
Sinking of River Piers.—The river piers were sunk entirely from floating plant moored in the river, which has a current as high as 6 m.p.h. Two floating pontoons, each measuring 100ft. by 30ft., were used for the purpose, carrying the necessary plant, cranes, compressors, mixers, &c., required during the sinking operation. The steel working chambers were built up ashore, launched and floated into position between the sinking pontoons. Concrete filling was at once commenced in the haunches around the working chamber, and carried up over the roof. Lengths of air shaft were added as the filling progressed, while the exterior steel shell plating was carried up and strutted as required. At the time it was pitched on the river bed, the west caisson displaced about 4500 tons. Work on the sinking of this caisson is shown in Fig. 7, page 282.

During the operation of lowering the caissons and pitching them upon the river bed, approximately 50 tons of concrete anchor blocks, weighing from 4 to 7 tons each, were used on the upstream side of the caisson and 82 tons on the downstream side. Wire ropes were led from attachments on the caisson skin plating around blocks secured by mooring chains to the anchor blocks, and back to winches mounted on the sinking pontoons. In addition to these moorings, independent anchorages were made to points on the river banks. The sinking pontoons were moored independently of the caissons.

Concreting was carried out by two 7-ton derrick cranes. Two 300 cubic foot Broom and Wade compressors were provided with a standby portable in case of emergency.

After pitching each caisson on the river bed, it was only possible to concrete up the walls of the machinery chambers to a level 16ft. above the floor, prior to founding the caisson finally. This action was necessary, as portions of the steel work supporting the bascule trunnions and approach span bearings were embedded in the upper portion of the concrete walls. The steel work naturally could not be finally set until after the caisson was founded, and its position accurately determined. For this reason the last 17ft. of the steel shell plating of the machinery chamber had to be temporarily supported by timber strutting. As soon as the caisson was founded in position the tower steel work was set and the concreting of the walls completed.





FIGS. 5 AND 6—LAUNCHING THE EAST SPAN

Erection of Approach Spans.—The steel trusses and portions of the deck of the shore ends of each approach span were erected upon the reinforced concrete decks of the approach viaducts behind the abutments. The shore ends of the spans were provided with rollers travelling upon specially prepared tracks on the viaducts. The river ends of the spans were cantilevered forward over the river, the spans being supported upon timber bends placed between the abutments and the river walls. When the spans were completed in this position, barges were floated under the nose end of each span, which was then raised clear of the support behind the river walls and carried between the rollers at the tail end and the barges. The barges were then towed out towards the river piers and the nose ends of the spans finally landed

* No. I. appeared September 9th.

in the correct position upon the tower steel work, the tail ends of the spans travelling forward upon their rollers. The photographs reproduced in Figs. 5 and 6 show the launching of the East span.

Erection of Bascule Span.—The whole of the steel work and counterweight of this span was erected in the open position. Upon completion of the steel work each leaf was lowered in turn, and the deck erected in the horizontal position. The photograph reproduced in Fig. 8 shows erection work on the bascule spans in progress.

The contract for the construction of the bridge was placed with Dorman, Long and Co., Ltd., in the summer of 1929. The erection of the bridge was completed by June, 1931, no less than five months ahead of contract time.

The British Association.

No. III.*

Railway Traction.

On Monday morning, September 5th, Section G devoted itself to a discussion of various aspects of the development of railway traction.

The first paper, by Sir Seymour B. Tritton, K.B.E., dealt with railway traction by steam power, and is reproduced on page 279.

Oil Traction.

Sir Henry Fowler made a statement of the present position of oil traction on railways, with necessary references to the historic side of the question, but without attempting to go into the details of the construction and working of oil transport, or to suggest definitely the position it would finally occupy on railways. In this paper Sir Henry recalls the view held by Sir Frederick Bramwell about fifty years ago, that the internal combustion engine would be the principal producer of power for all purposes before this date. This was dealt with last year in the "Bramwell" lecture, which had constituted the presidential address to Section G by Sir Alfred Ewing (now President of the British Association). Although it is only comparatively recently that special attention has been paid to this method of traction, says Sir Henry, naturally it has received consideration since the petrol engine was developed by Daimler in 1887, and since Diesel brought out his heavy-oil engine in 1895. There were certain difficulties of adaptation, some of which are hardly solved at the present day. In 1905 he examined all the existing applications in Western and Southern Europe, but could not then report on any as being moderately satisfactory. In 1912 a large experimental locomotive was built for the German State Railways, the frame, &c., being supplied by the Borsig Company, and the 1000 H.P. Diesel being manufactured by the Sulzer Company, of Winterthur, Switzerland. The engine was started by compressed air carried in a large number of "bottles" on the vehicle. It is said to have been the first and only large oil locomotive with a direct drive. He had the opportunity of seeing it, and recognised early the difficulties likely to arise when it endeavoured to start with a load of any size.

Generally, one may say that the lack of flexibility of the internal combustion engine for railway traction was not at first generally recognised. Undoubtedly progress would have been more rapid had the demands of railway transport, both from an acceleration and gradient standpoint, been more carefully considered. In addition, the operating staff had been accustomed to being able to increase the ordinary load without serious consequences. Even up to quite recently, if not to-day, there has been a struggle between having an excess margin of power and the extra cost of providing for this margin.

There is, and always has been, something fascinating in the idea of employing an internal combustion engine for railway transport. Ease of starting up, the elimination of turning at a terminus, the small attention required, the removal of the necessity for providing water, and other points give to a self-contained unit great advantages. There are, however, certain disadvantages—and Sir Henry deals only with the oil engine because, although there are a considerable number of units driven by petrol engines in the United States, he feels that their use is not likely to increase, in view of the improvements of the oil engine.

The three main points to be considered are: (1) weight, (2) flexibility and the necessary transmission, and (3) the economic standpoint. If these three matters can all be solved satisfactorily together, there can be no question of the success of oil traction on railways.

With regard to weight, the early Diesel engines were built for stationary purposes, with heavy frames, cylinders, &c., and the same features were carried forward when they were applied to traction. The remedy for this weight was to increase the speed of revolution. That success in this direction has been achieved can be judged from the fact that the ill-fated airship "R 101" was fitted with this type of engine. The increase of speed, however, entails some disadvantages, and it, and the desire to lighten all parts, have to be watched carefully in all designs.

* No. II. appeared September 9th.

The tractive effort is low on the level, but when running up an incline the percentage increase may be very great. Assuming that the tractive effort on the level is 15 lb. per ton (a fairly high figure), this will be about doubled by an up gradient of 1 in 150. With steam and electricity this can be met, at all events for a time, although perhaps by loss of speed. With an internal combustion engine, however, this is not so unless some type of variable transmission allows of an increase of torque. The most generally successful device for this purpose is electrical transmission, and this would seem to be the only practical one at present for locomotives of any size. Unfortunately, however, it increases the weight of the equipment, often the space required, and in all cases makes the plant much more expensive.

Ordinary gears, such as epicyclic, clutch, or plate (disc) are suitable only for small powers. They are not, as a rule, expensive, and are simple; probably they will always be employed for small engines. Several gears of the hydraulic type have been or are being tried, but, again, usually for small powers. There are two systems which depend on the compression of air by means of a Diesel engine, and the utilisation of this air, mixed with steam or by itself, in cylinders. This type has not been fully tried out, although a locomotive in Germany has been running for some time. The Kitson-Still engine might be looked upon as coming under the category of this type, whilst the same claim might be made for its inclusion under the category of steam engines.

Coming to economic considerations, Sir Henry said that, as compared with a steam locomotive for main line working, an oil engine locomotive will cost about double. This means a heavy overhead charge for interest and depreciation. Undoubtedly the first cost is high. The fuel costs undoubtedly are low, but the cost of oil for lubrication is probably considerably higher than when using either steam or electric traction for the same unit. There is the ease of drive, and probably the same claims can be made for a "one-man" drive in this case as with electric traction. Maintenance and liability to casualties we know little of, but the latter, at all events, although they might be high at first, should finally fall as low as with either of the other types of traction. The ease with which an engine can be re-fueled should not be lost sight of. The high first cost remains, but, like the electric motor, the oil engine can practically run the clock round, and in this direction can offer advantages over the steam engine in some cases, although some steam shunting engines do work the clock round, whilst in other cases, especially in passenger work, the long daily hours are not required. Each case must be worked out for itself.

Sir Henry then goes on to deal with the work which has been done with oil traction on railways, in shunting engines, rail cars and main line locomotives. For shunting engines there seems considerable scope, for in many cases they are required to work for long hours each day, with the resulting spreading of overheads. Circumstances will dictate whether one or two men are required. There is a very large number of this type of machine in use, ranging from those equipped with engines of from 400 to 600 H.P. down to very small units. The latter are nearly always fitted with mechanical transmission. One wonders whether this could not be made even simpler of operation, were it of the selector or Wilson type. In some of the smaller goods yards in Germany, and, he believed, elsewhere, in cases where the work does not warrant the provision of a fairly large engine and a driver, a small Diesel-driven shunting engine, with mechanical transmission, is provided. One of the yard staff is responsible for driving this engine when it is required.

It is probable that the internal combustion engine was first used for railway work in rail cars. They were, however, usually under-powered. It is with them more than with the other two classes that the difficulty of varying loads arises. A small branch will perhaps be worked efficiently for five days a week with one vehicle. The sixth day, however, is market day, and the traffic is doubled or trebled. The provision of power to allow of extra vehicles being attached adds materially to first cost. Again, for such work the long hours of service, which spread the overhead charges, are not often desired. This type of vehicle has been introduced on the Canadian National Railway, and it is interesting to note that the size of engine for the cars has increased. Many rail cars are used in the United States, but a large proportion use petrol. Denmark employs a considerable number, and Siam has many in service.

As to the main line locomotive, Sir Henry drew attention to an article published in The Engineer of January 29th, 1932, page 121, in which a list is given. He mentioned, however, that in addition to the Russian locomotives, one example is the Canadian National, in which, with two units coupled together, a horse-power of 2660 is obtained. Of great interest, too, is the "mobile power-house" of the Buenos Aires Southern Railway, in which the power unit supplies the attached train with current. In nearly all cases, however, electric transmission is employed.

It seems somewhat strange that certain countries, where the water question is a serious one, have not carried out more experiments. The whole problem, concludes Sir Henry, is one of the most interesting that confronts the railway engineering world at present.

Electric Traction.

Mr. F. Lydall, of Messrs. Merz and McLellan, consulting engineers, in a paper dealing with railway traction by electric power, confined himself to (1) propulsion by electrical energy transmitted to the trains from any source by track conductors, and (2) propulsion by self-contained power units in which the source of energy is a storage battery. Dealing with the relative advantages of these two systems, it is pointed out that under certain conditions the elimination of the track conductors by the use of batteries carried on the locomotives may be more important than the drawbacks arising from the capital cost of the battery system and the higher maintenance of the equipment, &c. Although for shunting and work in station yards battery locomotives have been employed, little has been done with this system in the general field of railway working. An interesting development in this direction, however, has followed the recent invention by Dr. Drumm of a new type of traction battery which has the special characteristic that it can be charged and discharged at rates which are very high in relation to its size and weight. Thus, it is possible, in a partial or boosting charge of only 20 minutes' duration, to store sufficient energy for an output of 2 watt-hours per pound of battery and to repeat the cycle of charge and discharge twenty times a day. This battery has been fitted to a two-coach train on the Great Southern Railways of Ireland, running a shuttle service between Dublin and Bray; but Mr. Lydall expresses the views that it is not likely that battery traction will supersede the present system of track conductors, and that with any form of battery at present available, this system of electric traction can have only a restricted field of application.

The main justification for the electrification of surface railways depends upon either (*a*) its ability to provide a service of passenger trains so much more attractive in respect of frequency and average speed of running than would be practicable with steam operation that the increase in revenue is greater than the extra cost of working and the charges on the new capital; or (*b*) the possibility of effecting sufficient reductions in the working expenses to provide a margin of profit after payment of interest and other charges on the additional capital required; or (*c*) a combination of these two possibilities. The first of these alternatives is generally applicable to suburban passenger services, but as regards those electrifications for which the calculable justification depends upon the ability to secure sufficient reduction in working expenses to meet the annual charges in respect of the new capital expenditure and provide some surplus as an inducement to embark on the undertaking, the author gives a warning against attempting to draw up a generalised balance sheet on what might be called a theoretical basis. Each case has its own individuality and must be investigated in detail, not only as regards capital expenditure, but the possible savings to be made on each item of working expenses. The paper, therefore, discusses in some detail the three principal items, which, together, make up about 75 per cent. of the total of those working expenses which are affected by electrification, viz., (1) locomotive fuel (or electric power); (2) wages of drivers and firemen; (3) locomotive repairs and maintenance.

Many detailed figures are given of consumption of coal and electric energy on certain sections of British railways, and the author's conclusion is that with the present price of coal, the question for this country of whether there is any particular saving due to electrification under this particular item will depend upon the proportions of the different classes of traffic. If the volume of passenger traffic is small and there is much shunting, there will be a saving; if there is much passenger traffic and little shunting a saving cannot be expected. At the same time, any increase in the price of coal over present prices would modify the comparison in favour of electric working.

Dealing with the relative wages of drivers and firemen with coal and electric working, it is pointed out that there would be a considerable saving in this respect by reason of the general speeding up of all classes of traffic except express trains. Something might also be allowed in regard to the time for cleaning and preparing locomotives in the sheds. As an example in this connection, reference is made to the figures prepared by the L.N.E.R. officers for the report of Messrs. Merz and McLellan to the Weir Committee. For the whole of the services on the sections included in the company's investigation (King's Cross to Leeds, Nottingham to Lincoln and Boston, Doncaster to March, and certain lines in Lincolnshire), it was estimated there would be a saving in wages of 20 per cent., or £132,880 per annum. The possible savings due to the operation of one-man trains are also referred to and the likely objections to a general reduction of staff in this way on main line working are discussed. This point was considered by the Weir Committee, whose view was that instead of reducing the number of men employed the ultimate effect would be to employ more, inasmuch as any scheme of electrification would include a considerable intensification of suburban services which would also

be favourable to the establishment of additional train-mileage in areas other than suburban.

In connection with locomotive repairs and maintenance, a number of figures are quoted from experience on electric railways in South Africa and India, and the claim is made that for any given scheme of electrification, the equivalent cost of locomotive maintenance should be less than half the corresponding cost under steam conditions, the correspondence implying not necessarily equal locomotive mileage, but an equal amount of work done. Experience has demonstrated that the mileage between heavy overhauls may be as much as 200,000 for electric locomotives, whereas the general practice is to send steam locomotives to the shops after less than half this mileage.

The paper also points to smaller, but nevertheless, important savings on other items after electrification, and also to the many incidental advantages, dealt with in the Weir report, which cannot easily be assessed. Finally, the author suggests to the railway companies that whilst coal will continue to be used for the production of power for railway purposes, it would be in their interests to leave the utilisation of coal to the power undertakings and to take the electrical energy so provided. The question for railways is essentially the same as for large factories. No modern factory is operated with a separate prime mover—either steam or oil engine—for each unit of plant. On the contrary, individual machines or groups of machines are driven by the simplest, cheapest, and most efficient power units available, viz., by electric motors, the more complicated business of power production being left in other hands. This was a modern development now firmly established and it could hardly be doubted that in the near future it would be recognised as the most advantageous system for a large part of the railways of this country.

Lieut.-Col. E. Kitson Clark, opening the debate and referring to the wear of rails, said he had always been interested in keeping the centre of gravity of rolling stock a little high; he considered that the centre of gravity on the Metropolitan Railway was getting very low indeed, and that that had a bad effect in the wear of the rails. A very great objection to the steam locomotive was the dirt caused in lighting up, and he asked if it were not possible to have some form of reservoir storage by means of which coal lighting up could be rendered more easy. Again, he asked why the Nicolson thermic syphon was not more widely used on locomotives. Locomotive boilers were inefficient in respect of steam area, and the giving-off surface for the steam was not as much as it might be. Why not, therefore, use the whole of the loading gauge, both in height and width, in order to get 15 per cent. increased steam area, and an enormous increase of the area in which the bubbles of steam could rise from the water surface? Again, it was extraordinary that the expansion valve had rarely been used on locomotives, and he instanced a case in which the replacement of a boiler had been rendered unnecessary by the use of expansion valves. Another suggestion was that, in order to reduce radiation from the whole body of the machine, it should be enclosed in a box, which could be streamlined.

With regard to the use of electricity for traction, he emphasised the importance of the cost of conveying it to the points of usage, and pointed to the damage which might be done to the transmission lines in the case of war or civil commotion.

Referring to the Kitson-Still locomotive, he said it was a bold attempt to carry through something which was wanted. Electricity had its place, but was expensive, and it would be an advantage to anybody using oil engines to eliminate that and apply a method of transmission which was less expensive, and which did not require a special trade to look after it.

Professor Lomonossoff, who designed the first high-powered electric transmission locomotive built, said that the objective criterion for determining which form of traction was most suitable for given conditions was the total cost per ton-mile gross, including the amortisation of the capital. In his opinion, in the present state of engineering and statistical knowledge, this value is predeterminable and not less accurately than are the stresses in a bridge. He put forward equations by which this value could be determined, and plotted the results obtained.

Mr. C. H. Merz, discussing the expense of electrical propulsion, said that in certain directions it was the cheapest. The claim for electrical working under proper conditions rested largely on the great reduction of cost of maintenance of rolling stock. It was interesting to consider other forms of transmission than electricity, from the internal combustion engine to the wheels, and if something practical could be developed on such lines it would enormously increase the suitability of the oil engine under certain conditions. But where traffic was dense, it was probable that electrical working would increase in this country.

Sir Josiah Stamp said that it would be bold to prognosticate for many years ahead the position in regard to fuel costs. The future of coal in this country was always likely to come into the middle of the political field, and the economic position as regards costs was uncertain. The cost of electricity, as delivered, was largely a function of total usage. Again, he wanted more knowledge of the relation between the period of physical durability of a machine and its obsolescence. Thirdly, he pointed out that American engineers were turning away from the inevitability of main line electric traction towards the extension of the possibilities of steam locomotives. In this country there were quite a number of advantages in the steam locomotive. There were the serious limitations of the loading gauge, and under the pressure of those limitations it was quite possible that further ingenuity would be displayed and discoveries made, particularly if the hammer-blow question were relieved. British railways were considerably reducing costs of maintenance per engine mile, and increasing the distance between overhauls, whilst there were devices for rapid acceleration similar to that of electrical services, so that the steam engine was not quite so out of date as some people believed. On existing stock there was a greater range of speeds than before. Thousands of locomotives were now expected to achieve a regular high performance, but no one knew what that would lead to in the way of real technical knowledge about costs. Railways had, however, some inkling of the way in which the speeding up might itself give rise to economies which would offset any increased coal consumption due to attaining greater speeds.

Dr. W. L. Lowe-Brown, who dealt with suburban railway traction, said that where stations were close together a high rate of acceleration was essential for a rapid service, and that acceleration depended upon the gross weight of the train and the tractive effort. Though an enormous amount of concentrated attention had been paid to increasing the power, he submitted that the same amount of thought had not been devoted to reducing the gross weight. For every ton of passengers carried on the railway, the motive power had to accelerate about 8 tons of weight. In an eight-coach train, carrying, say, 640 passengers, or 40 tons of passengers, the total weight to be accelerated was between 300 and 400 tons. The omnibus had a gross weight of 3 tons per ton of passengers, whereas the railway train had from 8 to 10 tons. A cynic had said that when a part of a railway train proved too weak, the engineer made it heavier; whereas when part of an omnibus was found to be too weak, the maker looked for a stronger material. No doubt if the same attention were given to reducing the weights per passenger on a train as has been given to increasing the tractive effort, that discrepancy would be largely reduced.

Mr. J. M. Fay, discussing the use of the Drumm battery, urged that under certain conditions a locomotive using a battery which could be charged very quickly, was of very robust construction and had long life, could help in the ordinary electrification by taking over those portions of a line having a traffic density too low to justify, for economic reasons, ordinary continuous contact electrification. A 1-ton battery would provide the necessary energy for more than 300,000 ton-miles per year.

Mr. C. J. H. Trutch, discussing oil-electric locomotives, referred to some which had averaged 150,000 miles, during which only one had required help. That was due to a short circuit in the electric equipment, and not to trouble with the engine. He had not yet found any transmission as satisfactory as the electric, and nothing appeared to have the prospect of being appreciably cheaper. The capital cost was not twice that of the steam locomotive. Further, he gave figures which indicated a saving of 43 per cent. in the annual working costs as compared with steam locomotives, which was very much higher than the saving effected by electrification. For suburban traffic in this country, however, the conditions were such that electrification was indicated.

Wing-Commander T. R. Cave-Browne-Cave agreed that for suburban traffic, electrification was unquestionably the proper thing, but suggested that the proper solution of the main line traffic problem was a mobile power station feeding ordinary electric rolling stock; the power station would supply power as soon as the train ran off the electrified track at the terminals. His suggestion was somewhat similar to that put forward by Mr. Ricardo in another connection. The present practice, of having one or two large engines designed to meet very special requirements should not be continued, but ten or twelve heavy-oil engines, such as are being developed for road transport and made in such numbers that production was cheap, failures rare and overhaul rapid, should be used. They would be coupled to high-speed generators and would need no more attention than the omnibus engine gets. Failure of one of these units would scarcely influence the timing of the train, and its replacement by a complete spare could be effected in, perhaps, two hours in any running shed. That system gave one-man control and no physical exertion. Adhesion was due to the weight of the train, not that of the locomotive; the locomotive, therefore, could be as light as the machinery allowed. It was fair to assume that the weight of the engine would be about 10 lb. per H.P., and the dynamo about 20 lb. per H.P., i.e., the power in electrical form for about 30 lb. per H.P., or 30 tons for 2000 H.P., which represented a weight immensely less than that which would have to be used for producing power in any other way. The advantages over steam locomotives would be quick acceleration at terminals and at most stops, quick turn-round, short overhauls, no more smoke and dirt than with electric power, no water to be used, and a great reduction of locomotive weight.

Mr. Fell suggested that the cost of an internal combustion engine main line locomotive would be about 2½ times that of a steam locomotive. For our heaviest main line locomotives we should require about 2000 H.P. oil engines to give a decent margin under all conditions. If one accepted electric transmission, the cost was about £8 per H.P. for transmission; that meant £16,000 before starting with the engine. The total cost would be about £13 per H.P., so that the locomotive would cost about £26,000, as against £10,500 for a steam locomotive to do the same duty. That appeared to rule out the use of heavy-oil engines for express passenger transport. Compression ignition locomotives of about 500 H.P. would seem to be suitable for branch lines.

Professor F. C. Lea said that the problem must be considered in connection with the fuel situation as a whole in this country, and emphasised the necessity for developing our own fuel supplies.

Sir Henry Fowler, in a brief reply to the discussion, said that the scheme described by Wing-Commander Cave-Browne-Cave was already used on a small scale on the New York Central Railway for local work.

Mr. Lydall, discussing the wear of rails on lines electrically operated, said it was frequently overlooked that the volume of traffic on such lines had increased very greatly in this country, and he questioned whether the increase of wear of the rails was greater than the increase of ton-mileage passing over them. In many places in other countries where there had been main line electrification, the traffic had, in certain instances, been increased, but he believed that where it had not been increased the wear of the rails had not been increased. As to the cost of fuels in the future, it was reasonable to assume that the price of coal would not be reduced very materially; it might go up, in which case the advantage of electrification would be increased. With regard to obsolescence, he asked if there were really any advantage in early replacements. If the efficiency was maintained at nearly 100 per cent. of the original, and the cost of maintenance was very small, there was no reason why early obsolescence should be insisted upon.

(To be continued.)

Industrial Rationalisation.*

By Commander C. W. CRAVEN, O.B.E., R.N. (Ret.).

I SUPPOSE the real subject of my address should be called "The Real Problem in Industrial Rationalisation," and in order to appreciate my views, whether you agree with them or whether you do not, I must briefly refer to the various methods which have been adopted in combining the component parts of the large companies into the form in which you know them to-day.

First, I will take the horizontal trust, which is the wedding of like with like. Followed to its ultimate conclusion, such a scheme would mean that you would have, for instance, one huge group of shipyards in the country with no competition except from foreign yards. No doubt the salesmen's duty in such a concern would be relatively simple, but I cannot help thinking that a huge combine of this kind would be difficult to control, and would breed inefficiency in its management. The system has, of course, the tremendous advantage that when times are bad, sections of the industry can be temporarily closed, and on a sudden turn for the better a nucleus of staff can be immediately supplied from those shipyards or works which are in operation.

On the other side, another line of thought prefers the vertical trust, where a given concern manufactures all its products right up from the raw material to the finished article.

There are difficulties in both systems. In busy times many of you know that in desperation a firm of, say, shipbuilders has felt it necessary to take shares in a steel works in order to ensure preference in the supply of plates and sections. This happened in several cases during the post-war boom. At that time also you will remember the terrible shortage there was of castings, following the disastrous moulders' strike, and certain marine engineers either purchased foundries or took a financial interest in them in order to ensure their supplies of castings.

After a certain amount of experience of both these methods of combination, I am afraid I take the view that neither is either absolutely right or wrong, but that what is really desirable for all practical purposes is a combination of both.

My ideal is an organisation where you have a horizontal group of, say, steel companies feeding, in addition to the outside market, a group of shipyards and engineering works. If times are bad in the latter, there is always the possibility of another outlet for the products of the steel works, and if times are bad in both groups, the organisation should be such as to permit of some of the works being temporarily closed and the work available being concentrated in those works which are kept in operation.

Much has been written, more has been spoken,

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* Institute of Marine Engineers. Presidential Address, September 13th, 1932.

about this so-called rationalisation of industry, but whatever views should prevail eventually, you cannot get away from the fact that the success or failure of any scheme depends on the personal qualities of those who have to put it into operation. Whatever the industry, whatever the form of grouping that may be selected, I am convinced that the financial fusing of the companies or firms under the professional guidance of lawyers, accountants, &c., is a very simple thing indeed compared with the practical fusion of human beings who earn their living in the various component parts of the combine. I have had to deal with people who have had to leave their employment through no fault of their own, but simply because there were two people available to carry out one man's job, and who have told me that they knew I had chosen the better man to remain. On the other hand, I have found some people who could never overcome their intense loyalty to the old firm with whom they served, and who really felt that being loyal also to its new brother was almost dishonest. These two relatively small points will show you that there are human problems to be faced, which require considerable care for their solution.

I have heard it said that no one man should be responsible to the board of directors for more than 8000 people. Personally, I do not think you can lay down any hard-and-fast rule about a matter of this kind, but I do think that the only possible hope for success lies in putting responsibility only on those who are able to bear it. I am told that there is a serious shortage of men capable of acting as general managers of large undertakings. My own experience teaches me that the men are available if they are given a chance of proving their qualifications. Whatever may be the type of product, whatever may be the size of the undertaking or the nature of the appointment under consideration, the vitally important qualification for a post of great responsibility is strength of character. Every appointment of a man who has never previously had to carry heavy responsibility is bound to be in the nature of an experiment, but should a mistake have been made, I think you will agree that the guilty party is not necessarily the man, but probably those who put him into a position for which he was not qualified.

In my view, one of the dangers of a large combine is that, compared with the old family concern of the last century, those at the head of affairs may not keep in sufficiently close contact with the general body of their employees. If such is the case, I do not see how success can be achieved.

There is also a tendency, which I have noticed, where the rationalisation takes the form of a holding company, with various subsidiaries, each controlled by an independent board, for the directors of the holding company, who really are responsible to the shareholders for the management of the group as a whole, to hesitate to interfere sufficiently on particular questions of policy, and, instead of directing the boards of the subsidiary companies, to be led to a certain extent by them. The result may be that decisions are taken favourable to one company but contrary to the interests of the group as a whole.

There is no advantage in the amalgamation of industrial undertakings, even although engaged in the production of the same type of article, unless as a result savings can be effected and economies made, and even where these conditions operate, unless care is exercised in the selection of the *personnel* of the individual units which form part of the rationalised undertaking, there is a risk that the goodwill of one or the other may be entirely lost and the amalgamated concern left with surplus buildings and plant, involving heavy oncost charges without any increase in turnover over which such oncost can be spread.

There is no doubt that, in theory, both Capital and Labour should benefit by proper rationalisation of competing undertakings, where economies can be effected by the fusion of manufacturing interests and reduction in administrative and selling expenses, but danger lies ahead unless those responsible for putting the rationalisation into practice look further than the paper estimates of savings which can be made. The man who has run a small business successfully, even possessing the highest technical qualifications, may not necessarily be a proper person to deal with the ramifications of a large-scale organisation, nor be temperamentally fitted to delegate those duties which, in a large combine, the man at the head must leave to someone else to carry out. In other words, he may not be gifted with that spirit of leadership which enables him to get that team work out of his subordinates, without which success cannot be achieved. In this connection, I can see no hope for the future of an industry if it relies on the committee form of administration, of which we have all seen so much during the post-war period. The chairman and board of directors must, of course, be supreme in all matters affecting the policy of large undertakings, but it is my belief that in all matters concerning technique, production, costs, selling, and general administration, the responsibility should be placed by the board on the shoulders of the managing directors of the various constituent companies which comprise the group. The managing director, in turn, must delegate power and responsibilities to the general managers of the individual units of his company.

It must be remembered that all business started on an individual basis, and the chief of each concern took full responsibility and followed out a definite line of policy. We have now reached the days of amalgamations of interests, and if this is to mean that each unit of a group follows out its own line of policy, then I fear we sacrifice the one principle essential to success. I believe that in the type of administration which I have submitted for your consideration there is a possibility of retaining much of the close personal contact and unity of purpose so successful when firms were of much smaller dimensions than they are to-day.

I apologise for my having to appear a little egotistical in the way I have put this matter before you, but having chosen as my subject a matter the consideration of which has taken up at least three-fourths of my time during the last few years, I thought it would be more interesting to you if I gave the experience just as it came to me.

Barking-Upminster Electrification.

No. I.

THE L.M.S. electrified line between Barking and Upminster, which was put into service on Monday last, consists of two additional tracks with sub-stations at Upney, Heathway, Hornchurch, and Upminster, and has an approximate route length of 7½ route miles. Whereas it was previously necessary to change at Barking in order to pick up the District Railway trains, passengers from Upminster and intermediate stations can now travel electrically to the City and West End direct, and the scheme offers the additional advantage of relieving the two original steam lines that have not been electrified, from local traffic and of consequently increasing the capacity of the fast steam trains between Southend, Fenchurch-street, and Broad-street. The passenger stations at Upney and Heathway, which serve the two electrified tracks alone and which have island platforms, are entirely new, other stations on the route having been enlarged and modernised to suit the requirements of the extra track and electric service. At Barking the general lay-out of the station has not been altered, but an additional platform road has been equipped with live rails.

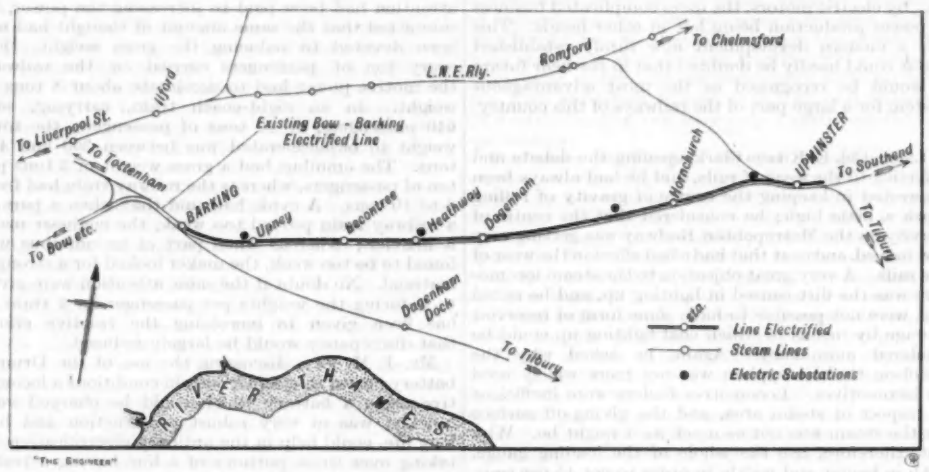


FIG. 1—MAP OF ELECTRIFIED LINE—BARKING-UPMINSTER

Current for operating the line is obtained from the County of London Electric Supply Company's sub-station adjacent to the railway company's Heathway sub-station, indicated near the centre of the map, other three sub-stations are controlled by means of equipment supplied by Bertram Thomas, of Hulme, Manchester. All the sub-stations have a capacity of 2400 kW, and whilst the plant at Upney and Hornchurch consists of rectifiers, that at Heathway and Upminster is composed of rotary converters, all designed for a bus-bar pressure of 630 volts. At Upney, Hornchurch, and Upminster the main transformers are mounted on concrete platforms outside the building, whilst at Heathway they are inside the building. All the E.H.T. switchgear for the sub-stations was supplied by A. Reyrolle and Co., Ltd., whilst the L.T. gear was supplied by Bertram Thomas, whom, as we have said, also made and installed the remote control gear. The rectifier equipments at Upney and Hornchurch were made by the General Electric Company and the B.T.H. Company respectively, and the same two firms built the rotary converters, the former being responsible for the plant at Heathway and the latter that at Upminster. Plans Fig. 1, where there are transformers which reduce the pressure from 22,000 to 11,000 volts. With approximately 2½ million car miles per annum, it is estimated that about six million units will be purchased from the supply company per annum. Between the sub-stations the three-phase, 11,000-volt feeders are arranged on posts on each side of the track, together with the pilot wires for the three remote controlled sub-stations, the sub-station at Heathway being the only one that has attendants. For the H.T. and pilot cables British Insulated Cables, Ltd., were responsible.

Although the scheme is not an extensive one and the track equipment is of the well-known third and fourth rail type, as used on the Bow-Barking lines, to which the new system forms an extension, the sub-station plant in particular is of interest. It may be mentioned, however, before describing this plant, that the conductor rails are of the standard flat-bottom type, weighing 105 lb. per yard, and the general arrangement of insulators, cables, gaps, rail switches, &c., corresponds with the latest L.M.S. practice. At the side of the line contactors are provided at section gaps approximately 250 yards, or the length of a twelve-coach train, ahead of the main gap at each sub-station, and are operated simultaneously with the track section circuit breaker by set and trip coils, the function of these breakers being to provide protection against a train bridging a sub-station gap and causing current to be transferred from a live section to a dead one.

From the attended sub-station at Heathway the

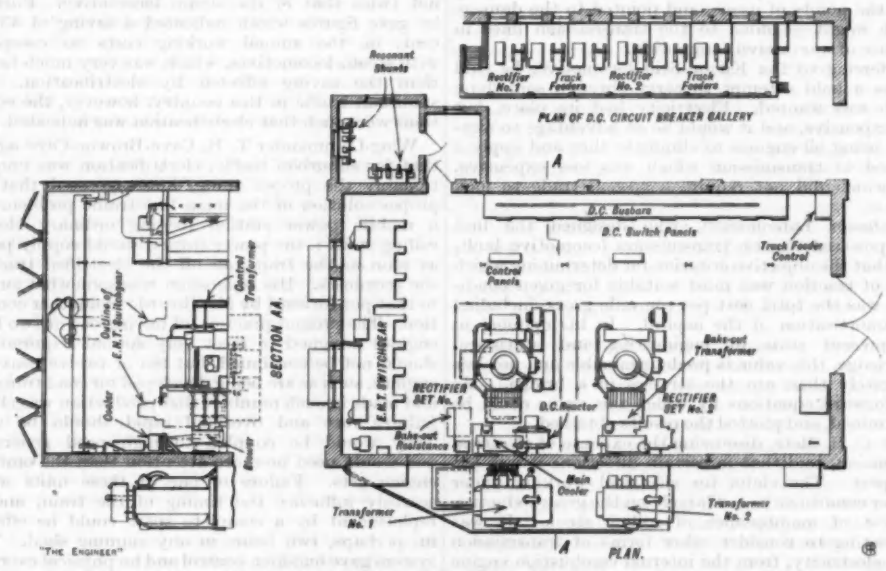


FIG. 2—HORNCHURCH SUB-STATION

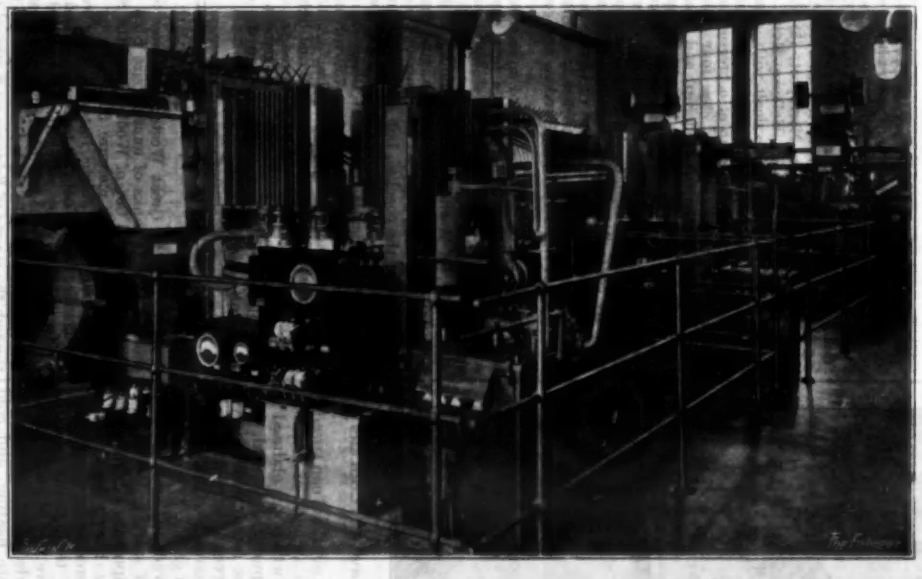


FIG. 3—GENERAL VIEW OF HORNCHURCH SUB-STATION

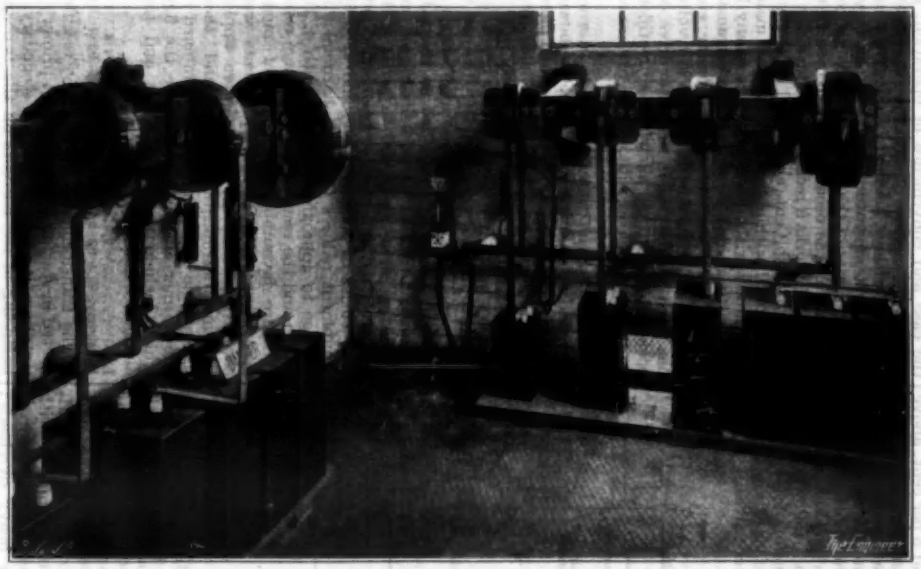


FIG. 4—RECTIFIER SMOOTHING CIRCUITS

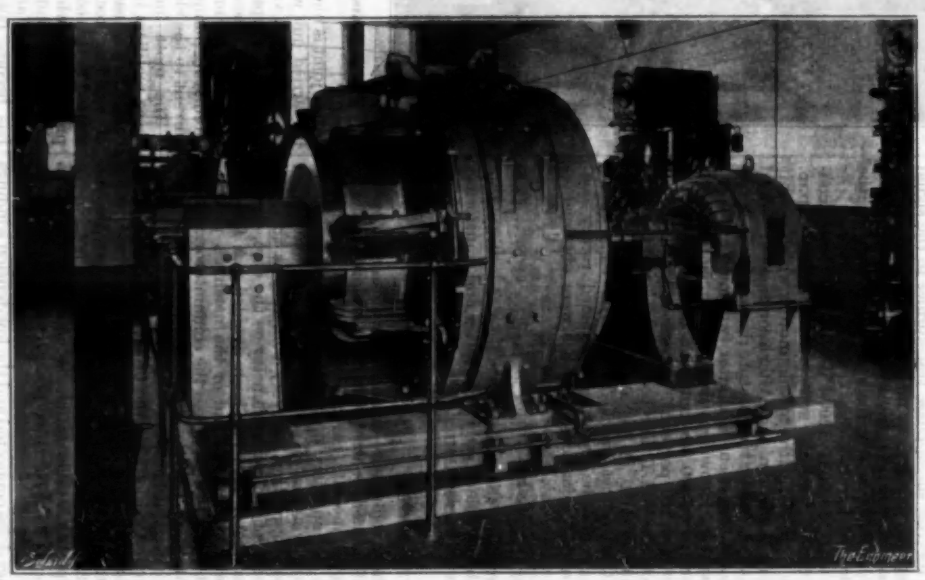


FIG. 5—ROTARY CONVERTER AT UPMINSTER SUB-STATION

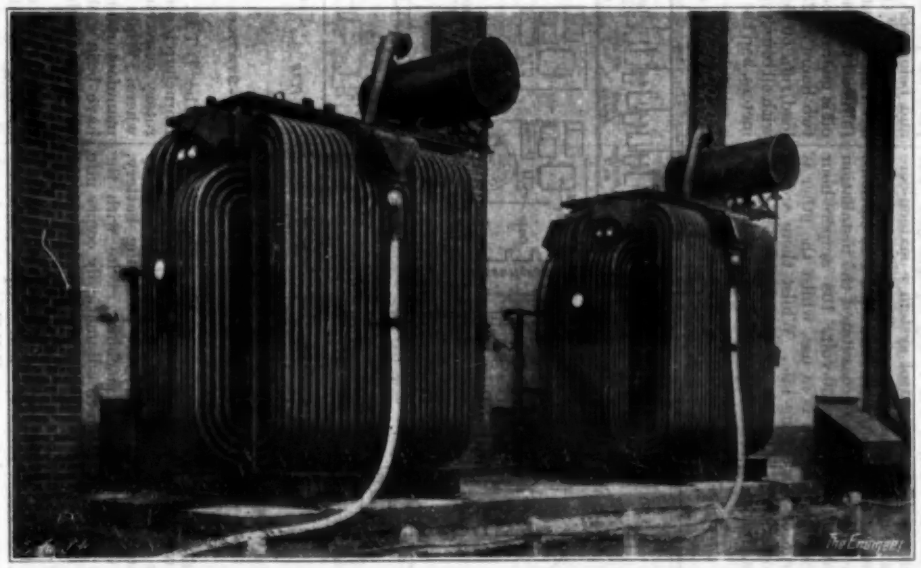


FIG. 6—RECTIFIER TRANSFORMERS AT HORNCHURCH SUB-STATION

of the two rectifier sub-stations are given in Figs. 2 and 7, whilst in Figs. 3–6 on page 277 views are given of the B.T.H. rectifier and rotary equipments. For the Bertram Thomas control system a sixteen-core pilot cable is run from the controlling sub-station at Heathway to each of the controlled sub-stations, and the system has also necessitated the installation at Heathway of two 250-volt, 108 ampère-hour batteries, one of which is in use, whilst the other is on charge or is standing idle. Whilst there are no main operating batteries in the controlled sub-stations, in each of the rectifier sub-stations there is a six-phase connection to the rotary converter slip rings. On the E.H.T. windings constant kVA tappings are provided at points 2½ and 5 per cent. above and below the normal voltage, and the connections are taken to "Off" load tapping switches arranged for external operation. After continuous operation at full load the temperature rise in the upper part of the oil is guaranteed not to exceed 45 deg. Cent. and after two hours at 25 per cent. overload, following a full-load run, 60 deg. Cent. The transformers are fitted with oil conservators, pressure relief pipes, dial thermometers, and the usual drain and filter valves.

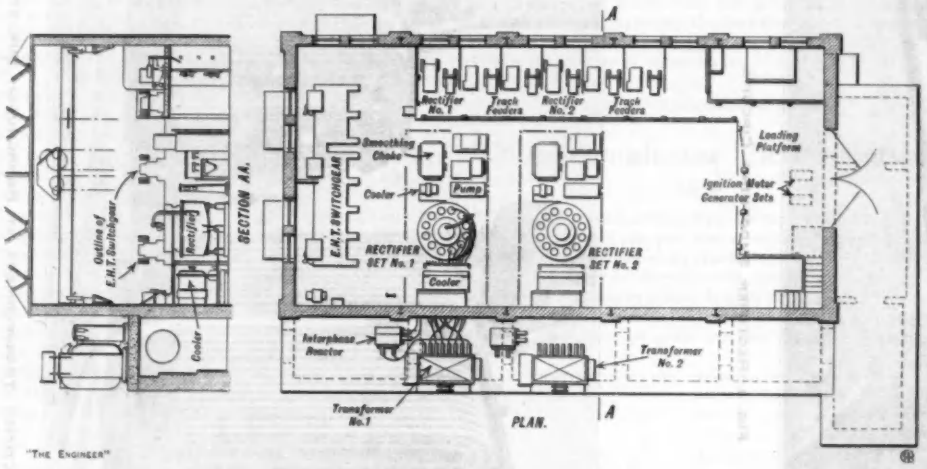


FIG. 7—UPNEY SUB-STATION

Westinghouse Saxby rectifier, which automatically comes into action in the event of the supply to the battery pilots failing, whilst in the B.T.H. rotary sub-station there is a 250-volt polarising battery, which ensures that the machines excite with the correct polarity and which automatically comes into action in the event of the failure of supply to the battery pilots from the controlling station. For each rotary converter or rectifier there are "Start," "Stop," "Close breaker," and "Open breaker" push buttons, and for each E.H.T. feeder and each track feeder there are "Close" and "Open" buttons. An indicator on each operating panel shows whether the signal has been received and whether the desired operation has been carried out correctly. If any oil switch or circuit breaker opens, an alarm bell rings and a red light indicates which circuit is affected. Continuous indication is also given at Heathway of the total load and bus-bar voltage at each sub-station, and a separate voltmeter enables the pressure of a rectifier to be measured before closing the D.C. circuit breaker. At each sub-station a supply is given by means of a 11,000/400-volt single-phase transformer to the signal and telegraph department for the automatic signalling of the new tracks, the transformers being connected to the E.H.T. switch fuses forming part of the Reyrolle switchgear.

The two 630-volt, 1200-kW B.T.H. rotary converters in the Upminster sub-station run at 600 r.p.m. and are equipped with starting motors which permit of series self-synchronising. After a continuous full-load run the thermometer temperature rise is guaranteed not to exceed 40 deg Cent. and after two hours at 25 per cent. overload following a full-load run, 50 deg. Cent. An overload of 100 per cent. can be carried for ten minutes and 200 per cent. momentarily, the power factor on the E.H.T. line being approximately unity from half-load to 50 per cent. overload. By the summation of measurable losses after tests at the B.T.H. works the following combined rotary converter and transformer efficiencies were obtained :—

Load	2/4.	3/4.	4/4.	5/4.	6/4.
Efficiency, %	92·60	94·09	94·59	94·63	94·53

After making the B.S.I. allowance for stray load losses the combined rotary converter and transformer efficiencies are as shown below :—

Load	2/4.	3/4.	4/4.	5/4.	6/4.
Efficiency, %	92·30	93·64	93·99	93·88	93·53

As the machines are arranged for automatic operation with remote control gear, they are provided with bearing thermostats, earth leakage relays, speed limit devices, and auxiliary shunt fields. The self-equalising armature winding is equivalent to one having an equaliser connection to every coil, and as the commutator is of the same diameter as the core, the use of commutator lugs has been avoided. A fan and cover at the slip ring end of the machines produce an air blast outwards across the commutator. At the commutator end insulating screens are provided over the bearing and baseplate and over the outer end of the commutator, and as the brush brackets are fitted with flash barriers the machines are claimed, when protected by suitable circuit breakers, to withstand dead short circuits without injury. Each machine in the Upminster sub-station is supplied through a B.T.H. 1350-kVA, three-phase, oil-immersed, self-cooled outdoor transformer with the 11,000-volt windings delta connected and the low-tension windings arranged in accordance with the diametric scheme for

The B.T.H. steel tank rectifier equipments at Hornchurch are designed for the same output as the rotary converters at Upminster and the plant elsewhere. While similar in design to other equipments manufactured by the company, various improvements have been embodied in these rectifiers. The main features which are common to previous B.T.H. practice are: (*a*) the anodes are equipped with graphite tips and screens to ensure freedom from melting and deterioration under heavy overloads; (*b*) six excitation anodes are provided to give stability of the arc even at the smallest loads; (*c*) all main joints are sealed with mercury, so that a continuous indication of the tightness of each joint is given and appreciable stresses on the insulators are avoided; (*d*) the anode plate, which has a simple mercury

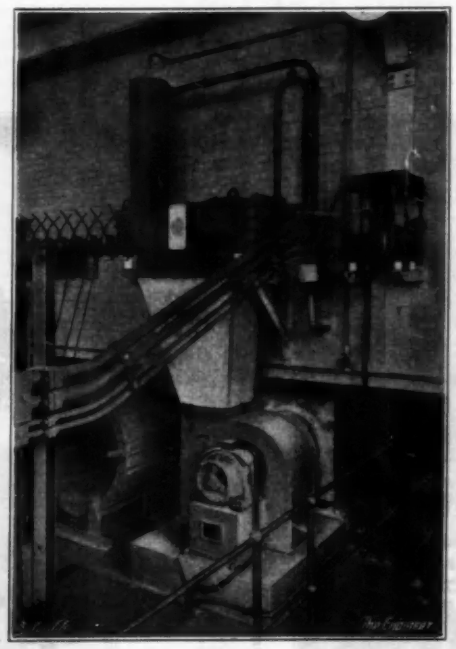


FIG. 8—MAIN AND AUXILIARY RE-COOLERS

sealed joint is removable, and an overhaul can speedily be carried out with a minimum amount of trouble; (*e*) the B.T.H. vacuum pumps, which are claimed to give an exceptionally high pumping speed, are mounted on the rectifier, and the motor which drives the rotary vacuum pump also serves to drive the main circulating pump and a small generator which supplies current to the electrical vacuum gauge.

The most important improvement embodied in these rectifiers is the method of starting them when cold. In the early B.T.H. equipments the difficulty of enabling rectifiers to carry heavy loads when started in this condition was overcome by a system of pre-heating, which raised the temperature of the rectifier to a suitable value before it was put on load. By the use of an improved anode shield, however, it has become possible to eliminate heating, and cold rectifiers may be started and put on heavy loads without the delay which the heating process involves. This new feature, which is claimed greatly to increase the ease and convenience of operation, is obtained without the sacrifice of any of the desirable characteristics and without having to reduce the maximum safe operating temperature. The satisfactory operating characteristics of the scheme can be gauged from the fact that on the occasion of a demonstration test at the B.T.H. works a rectifier was started at a temperature of 5½ deg. Cent. and a load of 2½ times full load was applied within two minutes and maintained for ten minutes without disturbances of any kind occurring. By means of a bake out transformer and resistance in the sub-station under consideration either rectifier may be loaded at low voltage after it has been overhauled in order to drive off traces of occluded gases, thus allowing the rectifier to be put on its heaviest load without any further conditioning process.

As there is no water supply at Hornchurch fan-operated re-cooling equipments, as shown in Fig. 8, are provided both for the rectifier and mercury pump, and the blower for the main re-cooler operates intermittently under thermostatic control, whilst the mercury pump re-cooler operates continuously in the same manner as the pump itself. In order to eliminate any possibility of telephone interference a complete smoothing circuit is provided on the D.C. side, the equipment, which is shown in Fig. 4 on page 277, consisting of a choke coil in series with the main negative lead and a set of resonant shunts tuned to frequencies of 300, 600, 900, and 1200 cycles. The equipment reduces the main harmonics in the D.C. voltage to approximately one-tenth of their normal value, and the resultant D.C. voltage wave is said to compare favourably with that of modern rotary converters. When the equipments were on test several dead short circuits were applied to them without detrimental effects, and there was no measurable evolution of gas. Combined rectifier and transformer efficiency tests gave the figures below, which include the stray losses and those in the auxiliaries and smoothing circuit.

Load	1/4.	2/4.	3/4.	4/4.	5/4.	6/4.
Efficiency, %	93·22	94·0	93·95	93·7	93·37	93·0

The transformers supplying the rectifiers are connected in star on the 11,000-volt primary side and in six-phase triple star on the secondary side. The balancing of the currents on the two anodes which are in parallel on each secondary phase is done in the main transformer, and there are no anode reactors or interphase transformer. The rectifier control panel is provided with the necessary contactors and relays for the protection of the plant and for starting up and shutting down after the initial impulse has been received from the remote control gear.

(To be continued.)

RAILWAY ELECTRIFICATION IN DENMARK.

IN 1926 the Danish Ministry of Public Works decided to prepare a scheme of suburban railway electrification in Copenhagen, and the Committee appointed to consider the matter issued its report in October, 1929, whilst in April, 1930, the Danish Parliament passed a law authorising the work. The lines involved are: (*a*) Valby-Copenhagen Central-Copenhagen Norreport, (*b*) Frederiksberg-Vanlose-Hellerup, and (*c*) Hellerup-Holte. The total length of double track to be dealt with, apart from that at workshops, &c., will be 38 kiloms. The lines are to be electrified on the D.C. system at a pressure of 1500 volts, and the track will be fed by four sub-stations at Enghaveiiej, Flintholm, Hellerup and Holte. Three-phase, 50 cycle current at 10 kV will be supplied to the sub-stations from the Copenhagen Municipal Power Works, and from the N.S.E.A., the large electricity undertaking in North Sealand. All the sub-stations are to be remotely controlled from a distant control station. The contracts for the sub-station work have been awarded to Brown, Boveri and Co., Switzerland; Allmänna Svenska Elektriska A/B, of Vesterns, Sweden, and certain Danish firms.

Trains will consist of one or two units composed of two motor cars and one trailer, with a total capacity of 250 seats and with a gross weight of 150 tons. The first contracts for the rolling stock have been awarded to A/S Fricks, of Aarhus, and Schandia, of Randers. As reported in our issue of July 15th, the English Electric Company has been awarded the contract for the electrical equipment of the coaches, but some of the motors are to be built to this company's designs at the works of A/S Titan and Thomas B. Thrige, of Denmark. Each motor coach will be equipped with four 750-volt motors, which will work in series-connected pairs. A 65-volt motor generator set will supply the control and lighting circuits. The current collectors will be operated by a compressed air system with an automatic arrangement for bringing the collectors to the down position in the event of the supply of air failing.

RECENTLY the Great Western Railway conveyed two thermal storage tanks of unusual size from the works of G. A. Harvey and Co., of Woolwich, to the Swansea Civic Centre. The tanks measure 35ft. long by 11ft. 1in. in diameter and each weighs 15 tons. They were towed up the Thames from Woolwich to Brentford and there loaded on to rail. As they were 1ft. 7in. beyond the loading gauge a special schedule of traffic was arranged for the week-end. The tanks made the final part of their journey through the streets of Swansea on a special trolley drawn by a tractor.

Railway Traction by Steam Power.*

By Sir SEYMOUR B. TRITTON, K.B.E.

IT is stated in many quarters that the steam locomotive for railway traction is dead, or will shortly become obsolete. Its newer rivals will produce reasons for its early demise, and their case will be heard with interest, but, in spite of certain obvious disadvantages, the steam locomotive is still holding its own, and the splendid records recently set up by our British railways are concrete evidence of its vitality. The remark is often heard that the speed of trains hauled by steam locomotives recently recorded is no greater than it was many years ago, and instances of high-speed runs are quoted in proof of this contention; but the greatly increased weight of the luxury trains now in use, with their dining and buffet cars, &c., and the long-distance runs made without stop, are often ignored; when taken into consideration it is clear that the present work done by the steam locomotive quite exceeds all previous performances.

Under the stress of rivalry and modern conditions probably greater advances have been made during the last few years than formerly. The details of these improvements and inventions have been so exhaustively dealt with by the technical Press that it is almost impossible for the author to introduce any novel suggestions. The object of the papers submitted to your Association is to promote discussion, so the author makes no apology for repeating much that has already been said, in the hope that the discussion may break some new ground. Although this is the British Association for the Advancement of Science, it has world-wide connections, but the author has confined his remarks chiefly to steam traction on British railways.

The general design of the steam locomotive has really been little altered since the early days of railways. This is due, it is considered, to the expansive use of steam, which enables it to be applied direct from the cylinders to the driving wheels. Direct drive from the cylinders to the driving wheels is still universal practice, and holds sway due to its inherent advantage of simplicity, mechanical efficiency and flexibility over a wide range of speeds. Such a drive is only possible when using an expansive medium such as steam from a boiler of sufficient capacity. It is in direct contrast to other forms of propulsion, in which power is obtained from a high-speed engine, with a reduction gear of some form to transmit power to the driving wheels. Every possible arrangement of variable gear mechanisms has been experimented with, as well as hydraulic, pneumatic and electrical transmissions, for this purpose. Examples which will at once occur to you are the marine turbine with geared propeller propulsion, the road motor car with its gear-box, and, for the lighter types of railway work, the well-known Sentinel rail car.

Whether the development of the high-powered main line steam locomotive will eventually be forced in this direction it would be difficult to predict, but until the principle has become a practical and paying proposition for main line work, the attraction of the simple "direct-action" drive of the present locomotive, with its expansive and cushioned steam impulse, still holds its own. The steam locomotive engineer will always enthusiastically uphold this expansive use of steam when comparing it with the "explosive" energy from which its internal combustion rivals obtain their power. An interesting example, however, of an ingenious design to combine the two systems is to be seen in the famous Kitson-Still engine. The engine is double-acting, with internal combustion at one end of the cylinder and steam at the other end, through which the piston-rod works. The water in the jacket is in connection with the boiler, and the excess heat from products of combustion assists in the production of steam in the boiler. The boiler is primarily heated by oil burners, and the steam generated is used for starting the engine. This unique locomotive, therefore, provides the combination of internal combustion and steam power, internal combustion for continuous work, and steam for starting, for overload, and for auxiliaries such as brakes, train heating, &c.

The disadvantages with which the steam locomotive has to contend when comparing it with its oil and electric rivals are obvious, but they will bear repetition. There is the wasteful procedure of producing steam by burning coal in the fire-box, with all its losses; the great expenditure on the conveyance and storage of coal; the cleaning of ashes and clinker; the enormous amount of water required (in spite of pick-up apparatus) and the hauling of its deadweight, together with the coal on the tender; the heavy expenditure on boiler repairs (especially with bad water,; and the standby losses of the locomotive when not actually performing work.

This is a coal-producing country, and cheap coal was the cause of the genesis of the railways here; and so long as coal can be obtained at a reasonable price, railway engineers will strive to use it in spite of its drawbacks. The Diesel engine has to use imported oil, and for electric traction, except where water power is available, coal is used to provide the power. The attraction of oil fuel for steam raising in the locomotive has long been before the locomotive engineer, and in countries where oil is cheap and coal is dear it is, of course, in use. In this country, for the reasons already mentioned, it is not in evidence, but during the last few years the whole aspect of the import of oil fuel, its marketing and distribution has so materially altered (witness the enormous quantities consumed by the Navy and the Atlantic liners), that, in the opinion of the author, the possibilities of its use on our railways cannot be altogether ignored. The cost of adapting steam locomotives would be great, but not insuperable, if the price were sufficiently low, and some security of cost could be obtained. There is also the possibility of pulverised coal, which is being so successfully used, both on board ship and in electric power stations.

The author was privileged to report on the earlier experiments made with oil fuel on the then Great Eastern Railway. A saucer-shaped fire was formed of chalk and coal, with which the run was commenced, the oil being subsequently switched on for the main portion of the journey, and the coal fire restored before reaching the destination, the idea being to enable the engine to stand by without injury to the boiler by cooling down before the return journey. The arrangement worked well, but was discontinued owing to the rising cost of the oil fuel. He was also present at, and reported on, the pulverised fuel experiments on certain locomotives on the then Midland Railway, the coal being pulverised by mechanism on the tender and fed to the fire-box under pressure. Much advance has been made since these experiments, and we have recently had brought to our notice the successful use of colloidal fuel, the mixture of coal and oil, which has hitherto baffled the ingenuity of chemists and engineers.

The author has referred in the above remarks to imported oil, but the possibilities of British oil fuel cannot be ignored. The following quotation from a letter in the technical Press reads:—"There is no subject that has caused or is still causing more interest and criticism than the well-known 'oil from coal subject.' The world seems to be passing through the coal-burning to an oil-burning age, and the coal pits will eventually be selling not coal, but gas, smokeless fuel and oil."

The author makes no excuse for dwelling on the question of fuel for steam raising, because the development of the steam locomotive, and the physical endurance of the human element, seem to have almost reached their culmination with coal fuel as at present used, and mechanical stokers have not yet found favour, in this country, at any rate. In this connection, improved springing and more comfortable riding of the machine is indirectly a factor which cannot be ignored if the long non-stop runs now being made are to be successfully continued. It might well be that with the use of one of the other fuels mentioned it would be possible to design still more powerful steam locomotives within the restricted loading gauge of this country without increasing the permissible axleload.

Here it may be permissible to digress for a moment to emphasise one reason at any rate which has handicapped the development of the steam locomotive in this country, namely, the restricted loading gauge of our railways. By loading gauge is meant the maximum and minimum dimensions which a locomotive must pass if it is to clear fixed structures, such as tunnels, platforms, &c. This country was the first to build railways, and it is only natural that the dimensions which at that time were considered generous should be quite inadequate for present-day requirements. This is especially noticeable when we come to the design of the boiler, and accounts for the practical disappearance of the chimney, which often puzzles the traveller.

A further difficulty is the weight of the locomotive, and more especially the distribution of it, which has gradually increased, calling for costly bridge renewals and heavier rails. The normal axleload, by which is meant the load measured at the contact of the wheel with the rail, in this country is about 20/21 tons, but engines with 22½ tons axleload are running in India, and one for 28 tons has actually been designed. In America this latter figure is actually in use. But the static axleload might be increased, certainly so far as bridges are concerned, if the latest research on the subject of impact on bridges is given effect to. With this is associated the hammer blow of the wheels on the bridges and rails, a subject which is stressed by the exponents of electric transmission when comparing the steam with the electric locomotive, and the latter's admittedly more even torque and better acceleration. The balancing of steam locomotives has not in the past received the attention which its importance deserved, but there is a movement on foot to investigate the effect on the running of the locomotive by reducing the proportion of the reciprocating parts which it has hitherto been considered necessary to balance. For any reduction obtained in the hammer blow it is reasonable to contemplate a corresponding increase in the static axleload distributed over the driving axles of a locomotive designed to run on existing rails, which would be a boon to the designer, and prove another direction in which the power of the locomotive might be increased within its existing restrictions.

The ultimate aim, apart from increased power and speed, is obviously the reduction of fuel consumption, and the best brains of the engineering profession have concentrated on this, the use and evolution of the superheater being one of the most important improvements now generally adopted. Mr. Gresley, in commenting on the author's presidential address to the Institution of Locomotive Engineers, however, made special reference to the need for greater economy in steam distribution. Without this, the economy claimed for the high pressures now being used, and the still higher pressures being experimented with, may be largely discounted. The economical distribution of steam by means of improved valve gear has been engaging the attention of designers, especially of late, and the latest forms of poppet gear, as illustrated in the Lentz and Caprotti types, are showing considerable economy over the Walschaerts gear in general use. The engineer who is not directly associated with steam power transmission is inclined to be critical when reviewing the coal consumption of the steam locomotive. The most modern and efficient power-house plant represents the maximum economy obtained in converting coal into energy at about 1 kWh per pound of coal of high calorific value and with a high load factor. It is difficult to make any real comparison with the steam locomotive on this basis, and naturally it is not feasible to carry about economisers and condensing apparatus of the size and efficiency found in an electric power station. But it must not be forgotten that experiments have been made in this direction. More than one locomotive has been built where the steam turbine is the prime mover, and an elaborate arrangement of condensers and fans is employed to deal with the large volume of exhaust steam. This problem of condensing the exhaust steam, whilst comparatively easy at sea, and on land where ample water is available, proved to be most difficult to solve in the steam locomotive of this type. Notable examples are the Ljungström, the Maffei, and the Ramsay. In the Ljungström and the Maffei, the steam turbine is connected by reduction gearing to the driving wheels, and in the Ramsay the turbine drives an electric generator supplying current to a motor driving a jackshaft coupled to the wheels. There is no doubt that these locomotives show considerable reduction in coal and water consumption, but so far it would appear that the advantages obtained have not outbalanced the disadvantages of high initial cost and upkeep.

It is in the boiler, however, that the greatest change is coming about. In spite of the reduced consumption above referred to, the demand is yet for more steam, and the use of higher pressures to promote economy.

It would appear that a steam pressure of 250 lb. per square inch is about the limit that can be used in a locomotive boiler of the present type, whose size and weight have reached their limits and must lead to a radical change in design.

There are several novel departures in high-pressure design for steam locomotive boilers, which may roughly be divided into two types—that which may be termed the three-stage, or, perhaps more happily, the multi-pressure boiler, and the water-tube boiler. There are several variations of each, and detailed descriptions would not come within the scope of this paper, but the Schmidt-Henschel, which is being tested on the London, Midland and Scottish Railway, is, perhaps, the most interesting of the multi-pressure boilers. In this boiler, steam is raised in a high-pressure drum by means of a closed circuit of tubes and headers (forming a fire-box) and an evaporating coil in the high-pressure drum, the steam being generated by indirect heat. This transfer process is, of course, not a new one, as it is in use for heating and cooking boilers, or cauldrons, but it has the advantage for high-pressure boilers that distilled water can be used in the coils, which does not suffer loss by evaporation, and the high-pressure drum, being fed with water from a low-pressure boiler section, and also not being in contact with the fire, is not liable to form scale. Steam is maintained in the closed circuit at about 1400 lb. pressure, and raises the pressure in the high-pressure drum to about 900 lb. This steam is fed to the high-pressure cylinder, and the exhaust steam from this cylinder, supplemented by superheated steam from the low-pressure boiler heated by the flue gases, is taken to the low-pressure cylinders at about 250 lb. pressure.

The water-tube fire-box has been experimented with extensively in America, but the most interesting example of the water-tube boiler proper is that of the London and North-Eastern engine "No. 10,000." In this locomotive, Mr. Gresley collaborated with Messrs. Yarrow, the well-known designers and builders of water-tube boilers for marine work, in evolving a water-tube boiler which could be successfully used for locomotive work. Such a boiler involved radical departures from marine and land practice. Perhaps the chief feature of this boiler is the long single steam drum which forms the backbone of the boiler, is large enough to admit a man, and into which water tubes are expanded, and from which, also, the lower drums are suspended, special arrangements being made for expansion.

The pressure adopted is a more moderate one than that of the multi-pressure boilers already referred to, being 450 lb. per square inch. A detailed description of the ingenious arrangements to provide for expansion, and to prevent the formation of scale, and the streamlining of the whole locomotive, cannot be given here, but has already been published.

No doubt modifications may be found necessary after further service, but this boiler has the great advantage of simplicity of construction, adaptability to modifications of heating and grate surface, and its application to the steam locomotive seems assured. The cost of maintenance, when applied to a new design, is often the measure of its success, and all indications point to a low cost of maintenance in a boiler of this type.

This *résumé* would not be complete without reference to the great improvements in the materials which can be used in the construction of the locomotive, although in this respect the steam locomotive cannot alone claim the benefit of them, as axles, tires, &c., are common to oil or electric locomotives, but the steam locomotive stands to benefit to a greater extent because of the use of special steels for boiler plates and tubes and steel connecting-rods weighing over 1 ton, which form such an important part of its design. We have seen, therefore, that the steam locomotive, restricted as it is in this country by the limited loading gauge and limited axleload, &c., is fulfilling the calls made upon it. Some of the present restrictions can be met by improved methods of balancing, especially in two-cylinder engines, permitting of higher axleloads, but if demands are still further increased, and further economies are to be obtained, the new designs of boilers with higher pressure, and the possible use of other or different forms of existing fuel seem the direction in which still further progress may be expected. Meanwhile, the steam locomotive in its simplest form, but with the latest improvements in detail, is fulfilling the demands made upon it, is handling the fastest and heaviest trains in use, and the demands of the user have so far been matched by the progress of the designer.

* Contribution to a discussion on "Railway Traction" before Section G of the British Association at York, on September 5th, 1932.

WIRELESS IN MINES.

FOR some time past experiments have been made with a view to establishing wireless communication between the surface and underground workings of coal mines, so that messages may be transmitted and received in a time of disaster. Certain colliery owners have given permission for the use of sections of their mines during week-ends, but it is in mines that are free from gas that the preliminary tests have been made. It has been found that satisfactory reception is possible at considerable depths in the intake air shafts. As there is always a certain amount of risk in the use of electricity in coal mines where there is gas, the Divisional Inspector at Doncaster had to be consulted before extended experiments under the wing of the Mines Department could be undertaken. More advanced tests are to be undertaken in the near future at the Manor Haigh Colliery, and at the Roundwood Colliery in Yorkshire, where semi-portable wireless installations will be erected. The transmitter will be rated at 0·25 kW and the aerial will be supported at the pithead on masts 35ft. high. Although obstacles such as blind spots are met with as the result of metalliferous veins in the workings, the experiments indicate that there is every chance of success and that wireless may prove of considerable assistance in the case of emergency.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

"OVER ONE HUNDRED PER CENT. EFFICIENCY."

SIR,—The conclusion arrived at in the leading article entitled "Over One Hundred per Cent. Efficiency" that appeared in your issue of August 26th is based on the erroneous assumption that the "volume after compression will be equal to the volume of the flue gases entering the turbine."

These volumes are not necessarily equal, but the weights are.

The volumes are not necessarily equal, for, with the use of the explosion method of combustion, the pressures of the gases entering the turbine are, during the greater part of the exhaust period of a working cycle, higher than the constant charging pressure produced by the compressor, even after deduction of the pressure drop, necessary for the production of the high velocities through the heating tubes.

By virtue of these pressure differences, the mean temperature of the flue gases entering the turbine can be reduced below the temperature of the charge leaving the compressor without sacrificing the equality of temperature range in turbine and compressor necessary to achieve equality in work performed. If, in addition to this, fuel and air enter the explosion chamber at a higher temperature than the mean temperature of the flue gases leaving the heating tubes, the attainment of over 100 per cent. efficiency under the favourable conditons enumerated in our "Revue" becomes possible—that is, more heat has become available for the generation of steam than is produced by the combustion of the fuel.

BROWN, BOVERI AND CO., Ltd.,
H. MEYER.

Baden, Switzerland, September 7th.

[We regret our inability to follow Messrs. Brown, Boveri's reasoning. Does not the elementary relationship $PV=RT$ render impossible their assumption that the pressure of the gases entering the turbine can be higher and their temperature at the same time lower than the corresponding figures for the incoming air, the volume of the furnace remaining constant? With regard to their last sentence, reiterating their claim for a possible efficiency of over 100 per cent., we have already pointed out, in the article referred to, that the plant could not work, even theoretically, under the conditions assumed.—ED. THE E.]

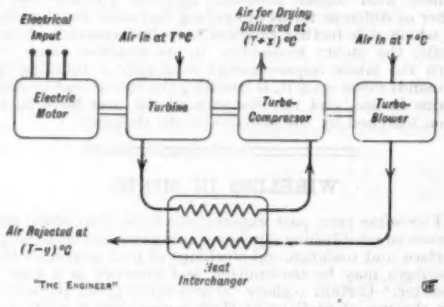
SIR, — May I point out that the criticisms by "M.I. Mech. E." of my previous letter are quite unjustified, since, in point of fact, he bases his arguments on a cycle, quite different from the Brown-Boveri explosion cycle which was under consideration? He assumes the following cycle :—

(1) Adiabatic compression.
(2) Combustion at constant volume.
(3) Cooling at constant volume.
(4) Adiabatic expansion to the initial pressure.

This, in effect, means that after combustion the whole of the gases are cooled at constant volume to a certain lower temperature and to a certain lower pressure, and that then the whole of these gases are admitted to the turbine at this same temperature and pressure. Neither of these operations actually happens in the Brown-Boveri explosion cycle, as was made clear in my previous letter.

One might add that no law of Nature is transgressed by a heating efficiency considerably greater than 100 per cent., if the suitable cycle has been chosen.

One might quote the following example as giving a heating efficiency of well over 200 per cent. under certain conditions. For use in a drying process, a large quantity



of air is required at slightly above atmospheric temperature. Electrical energy is available; fuel is not available, Then the following cycle, as indicated above, might be employed to enable the heat input to the drying air to be considerably greater than the electrical energy used.

It will be seen that air at T° C. is taken in from the atmosphere by a turbine, and is expanded to below atmospheric temperature and pressure. This air is then heated up at approximately constant pressure in a heat interchanger, the heating medium being atmospheric air supplied by a turbo-blower. The air from the turbine, after passing through the heat interchanger, is compressed to atmospheric pressure in a turbo-compressor, the temperature of the air at delivery from the turbo-compressor being $(T+x)°$ C.

Naturally, the turbine unaided will not be able to drive the turbo-compressor and the turbo-blower, but "make-up" power can be supplied from an electric motor as is shown in the sketch.

Now, the heat input to heat the drying air from T° C. to $(T+x)°$ C. will be very nearly equal to the electrical input to the driving motor plus the amount of cooling effected on the air rejected from the heat interchanger at $(T-y)°$ C.; and accordingly, the heating efficiency, as represented by the heat input to the drying air, divided by the electrical input to the set, will be considerably greater than 100 per cent. The higher the efficiency of the turbine and the turbo-compressor, the higher will the heating efficiency be. A. H. WARING.

Norton-on-Tees, September 11th.

EARLY LONDON RIVER STEAMERS.

SIR,—Mr. Gerald Aylmer's article in the current issue of THE ENGINEER was very interesting to us, as in 1822 Mr. Aaron Manby, who was then associated with this firm, completed the first iron ship propelled by steam.

The "Aaron Manby," as this ship was called, was wholly built at the company's works at Tipton, shipped in pieces to London and assembled in the Surrey Canal Dock at Rotherhithe. Her length was 120ft., with 18ft. beam, draught when fully loaded of 3ft. 6in., engine of 80 H.P., and was propelled by "Oldham's feathering paddle wheels."

The trial trip took place on May 9th of the same year between Blackfriars Bridge and Battersea on the Thames, and the designer was there to witness the complete success of the "Aaron Manby," when she steamed her course along the Thames with her complement of naval officers and others.

Not unnaturally, the event created something of a sensation, and the vessel was declared to be "the most complete specimen of workmanship in the iron way that had ever been witnessed." Indeed, so well was the vessel constructed that she was navigated without a single mishap across the Channel and up the Seine to Paris by Captain (afterwards Admiral Sir) Charles Napier, with Manby's son Charles (afterwards Secretary to the Institution of Civil Engineers) as engineer.

Two other vessels of much the same character were constructed at our Tipton works, but the further development of the iron steam vessel was afterwards left to localities which were geographically more favourably situated for the work.

For THE HORSELEY BRIDGE AND ENGINEERING COMPANY, Ltd.,
J. W. BAILLIE,
Joint Managing Director.

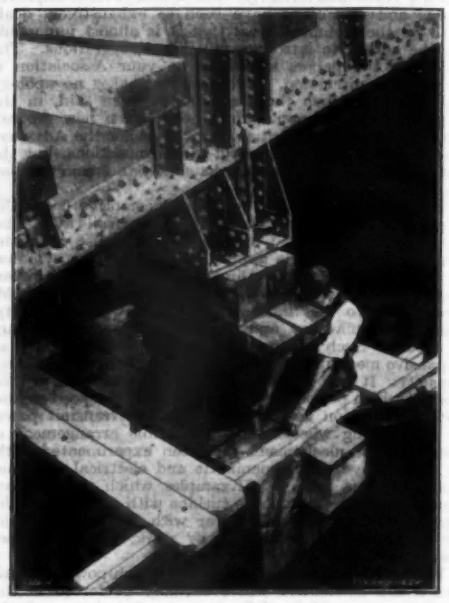
Birmingham, September 13th.

SIXTY YEARS AGO.

IT was a common saying sixty to seventy years ago that until a bishop had been killed on some of our railways no effective measures would be taken to prevent railway accidents. In our issue of September 20th, 1872, we suggested that a bishop might possibly be put to a worse use. Nevertheless, we felt some doubt as to whether the death of a dignitary of the Church would really be followed by a direct and immediate improvement in railway working, and so long as there was uncertainty on the point it would be unfair, we argued, to expect a bishop to make a martyr of himself for the good of the community. It was certain that with means already to their hands, the railway companies without the annihilation of a dignitary of any kind, could get rid of the worst class of accident on their lines. About 70 per cent. of all the so-called accidents which occurred on British railways must, we said, be classed under the head of collisions. It was quite unconvincing to assert that collisions were caused by the negligence of signalmen or drivers, to fog, to point failures, and so forth. With the single exception of wagons breaking away on inclines, collisions were caused primarily by the fact that a railway train running at speed could not be stopped promptly. What was required was the power to stop at will within a distance of about 100 yards. The root of the trouble therefore lay with the brake systems in use. Railwaymen still contented themselves with brakes on the tender and on a couple of guards' vans. The popular brake of the day was, we asserted, still identical in every respect with that used in the infancy of the Manchester and Birmingham line. It was very difficult to explain this apathy, an apathy which was almost criminal, except on the assumption that expenditure on new brakes was regarded as an illegitimate and unprecedent waste of funds. So far as we were aware, no locomotive superintendent had ever invented, or at least applied, a good continuous brake for use on the line under his charge. All the best brakes had been invented by outsiders, and had, literally, been forced on the companies. It was no part of our policy, as our readers were perfectly aware, to advocate the adoption of any particular patented invention. Nevertheless, without any hesitation we expressed the conviction that the adoption of such a brake as that recently introduced into this country by Mr. Westinghouse would reduce the number of collisions to vanishing point. It was futile for railwaymen to argue that there was still no satisfactory continuous brake in existence. All the principal American lines were using or were adopting the Westinghouse brake. It had passed far beyond the limits of its first stage, and its construction already occupied hundreds of hands in an American manufacturing establishment of great dimensions. It was quite possible that a far better brake might be invented, but with the development of the Westinghouse system it was no longer permissible for railway engineers to assert that they would adopt continuous braking if a good continuous brake were in existence. It already existed, and we challenged any one to point to a single statement in our argument which was contrary to truth, reason, and common sense.

Widening Putney Bridge.

ON Monday last, September 19th, a further step was taken towards the completion of the widened Putney Bridge, when the arches were successfully swung by the engineers of Dorman, Long and Co., Ltd., the contractors for the widening scheme. The bridge, it may be recalled, consists of five spans built in granite, which will be joined up to the existing bridge. During the process of building, the granite blocks were placed in position on steel girders which carried the weight of the arch. At about one-quarter of the distance from the main piers along each arch were fixed supports on which the girders rested. These supports consisted of wooden piles driven deep into the river bed, and on top of each one there was a watertight cylindrical iron box. The box, which is clearly shown in the accompanying illustration, was filled with specially prepared dry sand in which was embedded a plunger on which the girder actually rested. At the lower part of each box were nipples closed with iron bolts. On Monday last the bolts were removed and the sand run out of the iron boxes. The girders were thus gradually lowered



TAPPING A SAND BOX

by 1in. and the granite settled in position. Gradualness was the most important factor in the work of swinging the arches. The sand was removed from each nipple—of which there are four to each iron box—in small tins about the size of a half-pint measure. In order to obtain an even distribution over the whole length of the bridge during the removal of the sand, one man was employed at each iron box, making sixty men in all for the job. A syren was blown each time sand was to be removed, and this occurred at intervals of about ten minutes. The accumulated sand was measured at intervening periods, and throughout the process a number of engineers took measurements at various points on the bridge, which showed that the work was proceeding properly. We are indebted for this photograph and particulars above given to Mr. G. A. Maunsell, M. Inst. C.E., B.Sc., Dorman, Long and Co.'s agent for the Putney Bridge widening contract.

KEMPE'S ENGINEER'S YEAR BOOK.

WE desire to remind all users of "Kempe's Engineer's Year Book," which is now owned by the proprietors of THE ENGINEER, that the Editor will greatly appreciate any suggestions for increasing its value to its many readers, and particularly notification of errors or omissions. In the current issue tear-out sheets have been provided at the end for the use of any users who have comments to make. The utility of a reference book like "Kempe" depends in no small measure upon the co-operation of those who use it. The Editor hopes therefore that all who fail to find in it the kind of information they want and that may be reasonably sought in a volume of the kind, will communicate with him. The undiminished popularity of the "Year Book" shows that it does meet a real want, but the Editor hopes, with the help of its readers, to make it more indispensable than ever.

AMONG the items dealt with by Lieut.-Colonel Mount in his annual report on the railway accidents of 1931 was the number of failures of couplings. He reports a satisfactory decrease therein, but observes that the chief weakness, however, is the pulling out or breakage of draw-bars and hooks, a matter which merits, and has been receiving, considerable attention. The analysis of the failures reported shows that 1013 failures occurred on passenger trains, and 4922 on freight trains. Of the former, 47·3 per cent. were the pulling out or breakage of draw-bars or hooks; 24·9 per cent. the breakage of coupling links; 19·1 per cent. the breakage of screw shackles, and 8·7 per cent. were uncoupling. The corresponding proportions of the failures in freight rolling stock were 57·3, 29·0, 2·7 and 11·0 per cent. respectively. In 16·6 per cent. of the passenger train failures the train was double-headed. In thirty-one cases on freight trains collisions and derailments followed.

Railway and Road Matters.

THE new all-electric signalling at King's Cross, London and North-Eastern Railway, is to be brought into use in two stages, the first on October 2nd and the second on the 30th idem. The whole of the terminus will be worked from one signal-box.

THE morning boat from Folkestone to Boulogne and the corresponding noon boat from Boulogne, will be withdrawn as from October 2nd. The night service between Dover and Ostend and *vice versâ*—given by the steamers of the Belgian State Railways—ceased to run on September 4th.

THE rapid development of the area served by what is known as the Dartford loop, *i.e.*, from Hither Green to Dartford *vid* Sidcup has led to the Southern Railway running thirty-three additional trains on each weekday and fifty-one more on Sundays. There will now be four trains per hour in each direction on every day of the week.

THE recently issued Ministry of Transport railway statistics for the month of June last show that, compared with the corresponding period of 1931, the number of passenger journeys decreased by 2·6 per cent. and the receipts from passengers by 5·7 per cent. The passenger train mileage was reduced by 2·5 per cent. The tonnage of freight carried fell by 3·6 per cent. and the receipts by 7·5 per cent., with a drop of 1·9 per cent. in the freight train mileage. The average train load decreased from 121¾ to 117¾ tons, and the net ton-miles per engine-hour from 451½ to 444¼.

THE piers at North Queensferry and South Queensferry, which belong to the London and North-Eastern Railway as inheritors of the North British Company's ferry across the Forth, are to be improved so as to permit the ferry steamer service to be operated independently of the tide. Much of the work involved is of a difficult nature, and, being under water, will require to be done by divers. With favourable weather conditions it is hoped that operations may be completed about the beginning of November, and the ferry steamer service will then operate on a fixed daily time-table.

ONE of the reports on the more serious accidents to railwaymen during the October–December, 1931, quarter included in the Blue-book mentioned herein on August 26th related to a collision between two platelayers' trolleys that were conveying sleepers. The collision was reported as due to the mishandling of the brake stick when descending a gradient of 1 in 143. There was only one hole in the flooring through which to pass the brake stick, but it could not be used, as, owing to a curve, the flange of the wheel was pressing closely to the framing. Mr. J. L. M. Moore recommends that as the gang in question have over a mile of 1 in 75 gradients, on their length, they should have trolleys with properly designed and fitted brakes.

IT is reported that the scheme for pooling the competitive traffic of the London, Midland and Scottish and the Great Western companies approaches completion. Whilst much less spectacular than the L.M.S. and L.N.E. arrangement, it will serve a useful purpose as regards, for instance, the traffic between London and Birmingham and Wolverhampton; London and Chester and Birkenhead; and Birmingham and Bristol, and between competing points in South Wales. It will, moreover, lead to the elimination of such jointly owned lines as the Shrewsbury and Hereford; the Chester and Birkenhead; the Great Western and Great Central; the West London and the Severn and Wye; also the joint stations at Bristol, Worcester and Chester.

THE Railway Returns of the British railways for 1931 show that the number of steam, electric, and petrol locomotives owned was, on December 31st, 22,373, a decrease over 1930 of 425. The total empty deadweight of the steam locomotives decreased from 1,062,943 tons to 1,050,685 tons, but the average weight per locomotive increased from 46·72 to 47·06 tons. The proportion in use was 89·82 per cent. of the number available for traffic, but that number is exclusive of the 1141 locomotives in serviceable condition which have been stored and withdrawn from service. The coal consumed was 12,266,825 tons and the quantity of lubricating oil was 33,209,776 pints. The former gives 53·12 lb. per engine-mile and the latter 6·41 pints per 100 miles.

THE question of automatic stops on rapid transit lines may again be referred to by recording that the colour light signals on the Barking and Upminster line, mentioned in our Seven-day Journal of September 9th, have an improvement in the operation of the train stops with which they are provided. Connected to the track circuit immediately in the rear of the signal is a time relay which, at the expiration of one minute from the train coming to rest, allows the stop to operate and for this to be followed by the exhibition of a small yellow light—yellow being the caution indication—in the lower of two lamps on the signal. The motorman may then ignore the upper red light and proceed, with caution, as far as the line is unoccupied or until he reaches the next signal. This improvement saves the motorman from alighting from his cab to raise his trip clear of the arm of the stop and then to reset it, and it ensures the definite obedience to the one-minute rule.

THE withdrawal, as from September 10th, of all passenger traffic from the Basingstoke and Alton branch of the Southern Railway prompts a reference to the history of that line. It was the first to be built under the Light Railways Act, 1896. In January, 1897, the Light Railway Commission inquired into its merits. The Order was issued on December 9th of that year, the first sod was cut on July 22nd, 1898, by the then President of the Board of Trade, and the line was opened on July 1st, 1901. It was closed in 1916 so that the track materials could be used for war purposes, and, because the line did not pay, powers were sought to abandon it, *i.e.*, not to restore the track. An effort was made in Committee to delete this clause, but the Bill was passed. In the House of Lords, however, the railway company met the opposition by agreeing to reopen the line, and test the results for ten years. It was therefore restored and reopened on August 18th, 1924. As the railway is still open for milk and goods traffic, the company has not broken its undertaking.

Notes and Memoranda.

A PECULIAR freak of nature has developed in the waters off the Pubnicos, Nova Scotia, in connection with eel grass, which is manufactured into "quilts" used in construction of buildings for insulation and sound deadening effects. Heretofore the harbour has been covered with an abundance of eel grass, but this year not a blade is to be seen.

THE new electric lighting plant at Kuala Kangsar, Perak, comprises one three-cylinder vertical airless injection engine developing 150 B.H.P. at 300 r.p.m., and one three-cylinder engine of similar type developing 67 B.H.P. at 500 r.p.m., both being products of Ruston and Hornsby, Ltd., Lincoln, England. The generators are by Crompton-Parkinson, Ltd., and the General Electric Company.

A FILLING mixture for dry batteries given in the *Chemiker Zeitung* contains the following proportions, by weight, of materials:—Natural manganese dioxide, 60; artificial manganese dioxide, 12; fine graphite powder containing 95 per cent. of carbon, 18; fine acetylene black, 3; and salammoniac, 7. The original voltage of a battery filled with this mixture is given as 4·75, whilst even after five hours' continuous discharge is is still 2·1.

THE Kohala Bridge, which links British India with the State of Kashmir, was damaged by a land slide last year, but it has now been repaired in a rather unusual way. The span which was crumpled has been replaced by a cantilever reaching out from one of the piers nearly to reach the abutment. The intervening space is bridged by a small suspended span. In the event of further subsidence of the bank, it will be a simple matter to mend the small span.

THE employment of ordinary crystallised sodium sulphite (Na_2SO_3, $7H_2O$) is, says the *Chemical Trade Journal*, proposed by the German chemist Drawe for the removal of dissolved oxygen from boiler feed water. This salt is very soluble in water and at ordinary temperatures it combines with the dissolved oxygen of water to give sodium sulphate in quantities so small that the boiler can work for a prolonged period without any dangerous accumulation of this sulphate. The process is said to be relatively cheap. The sulphite should be kept in the solid state, as in solution it rapidly reacts with the oxygen of the air and loses its activity.

IN an article in the *Contract Record*, based on a report of the Committee of the Canadian Electrical Association on the reinforcement of pressure tunnels with concrete, it is urged that as much time as possible should be allowed between the placing of the lining and the grouting, so that the shrinkage of the concrete may be well advanced. Grouting pressures up to 100 lb. or 110 lb. are common in tunnels for power development. In the Catskill water supply tunnels, so-called low-pressure grouting at pressures of 75 lb. to 90 lb., was used to fill the voids between the lining and the rock, followed by high-pressure grouting at 300 lb. pressure to force the grout in the small interstices of the rock. The internal pressures in these tunnels was very high, going up to as much as 1500ft. head.

AT Malakal Aerodrome in the Sudan during heavy rain the condition of the cotton soil is often extremely bad, the surface becoming paste-like after absorbing water, while even when the ground dries temporarily large cracks develop through which further rain percolates, reducing the whole mass to a bog-like state. To remedy this trouble, top layers of this cotton soil have been removed, and, after it has been pulverised, is mixed with asphalt in concrete mixers, a suitable solvent being employed. This produces a substance which, when put down in layers and subjected to rolling, does not set entirely hard, but, when cut up, say, by a tail skid, can quickly be rolled out smooth again; while at the same time it is found that the surface, though remaining to a certain extent plastic, can be relied upon to stand up to the weight of aircraft when machines are taking off, landing, or taxi-ing.

A BULLETIN just issued by the National Council of American Shipbuilders deals with the fouling of ships' sides. The information is based on analysis of the results of the operation of the battleship "Tennessee" and the destroyer "Putnam" of the United States Navy, a few privately owned vessels and eleven Shipping Board vessels operated in various long and short-voyage services. In order to eliminate the effect of tides and ocean currents, the study was confined to the operation of vessels in one direction only. It also was limited to periods extending to six months after docking. Corrections have been made to compensate for operation at different displacements and different speeds. The studies of the merchant vessels cover only low speeds. It is shown that the increased resistance due to fouling in the case of vessels four months out of dry dock required an average increase of 7·8 per cent. in power, while vessels five months out of dry dock required an average power increase of 9·6 per cent., and vessels six months out of dry dock required an average increase of 11·8 per cent. in power.

THE blow-down pipe of a boiler in Huddersfield blew off the bend, but fortunately no one was hurt. It was the practice of the owners to expand the pipe after the flanges had been screwed on, and after the operation of expanding to add a fillet of welding to the back of the flange. The object of the welding appears to have been to provide further sealing between the pipe and the flange rather than to add strength to the connection. It cannot now be ascertained whether or not the original screw threading of the pipe was such as to secure a good fit of the flange on the pipe, but in any case, after the flanges were fitted and the pipe bent as required, the pipe was tested by hydraulic pressure to 500 lb. per square inch, and appeared to be satisfactory. Commenting on the accident, the Engineer Surveyor-in-Chief, Board of Trade, says that it would seem that the screwed flange had not been a good fit on the pipe originally, and the welding at the back of the flange, while not adding materially to the strength of the attachment, had prevented leakage which would have given indication that the screwed connection was defective. The application of welding deposit at the back of screwed flanges is an effective method of disguising bad workmanship and is not good practice.

Miscellanea.

A CENTRAL factory for the manufacture of sugar in Mysore is likely to be started at Gandawal, the centre of sugar cane cultivation in the State.

CANADA'S imports of British anthracite continue to increase steadily. The figure for August this year is 196,828 tons, as compared with 88,361 tons for August, 1931.

IT is reported that at Antimok, near Bagnio, in the Philippines, a vein of ore containing from 2000 dollars to 3000 dollars worth of gold per ton of ore has been discovered.

A BRIDGE is to be built over the St. Lawrence, which will link the island of Montreal, near Lachine, with Caughnawaga on the mainland to the south. It will cost some 3,000,000 dollars.

THE third, and final, report of the Adhesives Research Committee of the Department of Scientific and Industrial Research has just been issued. It may be obtained from H.M. Stationery Office, price 2s. 6d.

THE Soviet oil export organisation has concluded an agreement with a group of French importers, headed by Petrofina Française, providing for the sale of over two million tons of Soviet oil in the next five years.

THE Gas Committee of Glasgow Corporation has decided to close down the McLaurin low-temperature carbonisation plant at Dalmarnock and to convert it for making blue water gas and ordinary gas. The plant has been run with a total loss of about £36,000.

IN order to reduce the number of joints in overhead trolley wires, Thomas Bolton and Sons, Ltd., have adopted a larger ingot of cadmium copper and can now produce coils of up to 12 cwt. weight, or half a mile of 4/0 S.W.G. trolley wire in one continuous length.

THE bridge which is to be built over the river Jumna at Delhi, by Braithwaite and Co., Ltd., will have twelve spans of 218ft. each. The girders will be 32ft. deep, carrying a roadway on the lower deck and a single line of rails overhead. The weight of the steel work will amount to 5600 tons.

THE Coventry City Council has decided to purchase the old Meteor Works of the Rover Company at a price of £40,000. The works cover an area of 7 acres. The Rover Company intends to use its Birmingham works as a motor machine shop and to concentrate its Coventry works at its new Helen-street premises.

THE Municipality of Mysore has decided to make provision for a supply of 4,000,000 gallons instead of the present supply of 2,500,000 gallons per day. The Chief Engineer's estimate for Rs. 3,00,000 to install new pumps, for increasing the capacity of the reservoirs, and for improving the water supply has been approved.

WE are informed that the Institution of Sanitary Engineers is now affiliated with the Federation of Sewage Works Association, U.S.A. Information as regards all the latest research work is obtained by the Federation, and will now be available to members of the Institution on payment of a small annual subscription.

A NEW manganese-nickel steel welding rod material, known as timang, has been developed in the United States. The material contains 12 to 15 per cent. manganese, 3 per cent. nickel, and a fractional percentage of carbon. It is useful for welding high-manganese wear-resistant steel, such as is found in crushers.

THE Treasury has made an Order under Section 10 (5) of the Finance Act, 1926, exempting amorphous carbon electrodes over 3ft. long, the cross section of which exceeds 12in. in both length and breadth with longitudinal slots exceeding 2in. in width and 4in. in depth, from key industry duty from September 7th, 1932, to December 31st, 1933.

THE Portuguese colony of Macao is to be provided with a dual water supply. A reservoir is to be constructed on the island of Colowan and drinking water supplied from it to Macao through a submarine pipe line 3 miles long. Water for other purposes will be taken from the river close to Green Island, and purified by settlement and filtration. The supplies will amount to 500,000 gallons and 1,000,000 gallons a day respectively.

WITH the discharge of 110,000 bunches of bananas from the s.s. "Telapa" at Garston Docks on Monday, September 12th, the L.M.S. Railway completed what is claimed to be a record in the rapid unloading and despatch of heavy banana shipments. four boats having been dealt with at the port in seven days. During the previous week three vessels had discharged at Garston a total of 329,000 bunches of bananas in thirty-six working hours, 2000 L.M.S. banana vans and fifty-nine special trains being employed to distribute the cargoes to all parts of the country.

A NEW system of seed sowing for reafforestation purposes has been developed in Norway. It consists of sowing little "bricks" of seed instead of young saplings. The seed bricks or briquettes are made of good soil and are 1¼in. by 1¼in. in size. Three or four seeds are placed at one end, near the surface. The briquette is then dipped in paraffin wax, except the side in which the seeds have been placed. The result is an easily transported product, which can be placed in the ground by means of a special tool designed for the purpose. A machine can turn out 16,000 briquettes in a day.

ACCORDING to the monthly report of the National Federation of Iron and Steel Manufacturers, there were fifty-seven furnaces in blast at the end of August, a net increase of one since the beginning of the month, two furnaces having commenced operations and one having been blown out. Production of pig iron in August amounted to 259,400 tons, compared with 292,600 in July, and 275,700 tons in August, 1931. The production includes 48,000 tons of hematite, 120,400 tons of basic, 70,700 tons of foundry, and 13,900 tons of forge pig iron. The output of steel ingots and castings in August amounted to 361,500 tons, compared with 438,400 tons in July, and 357,300 tons in August, 1931.

ERECTION OF THE BANGKOK MEMORIAL BRIDGE

DORMAN, LONG AND CO., LTD., MIDDLESBROUGH, DESIGNERS AND CONSTRUCTORS

(*For description see page 273*).

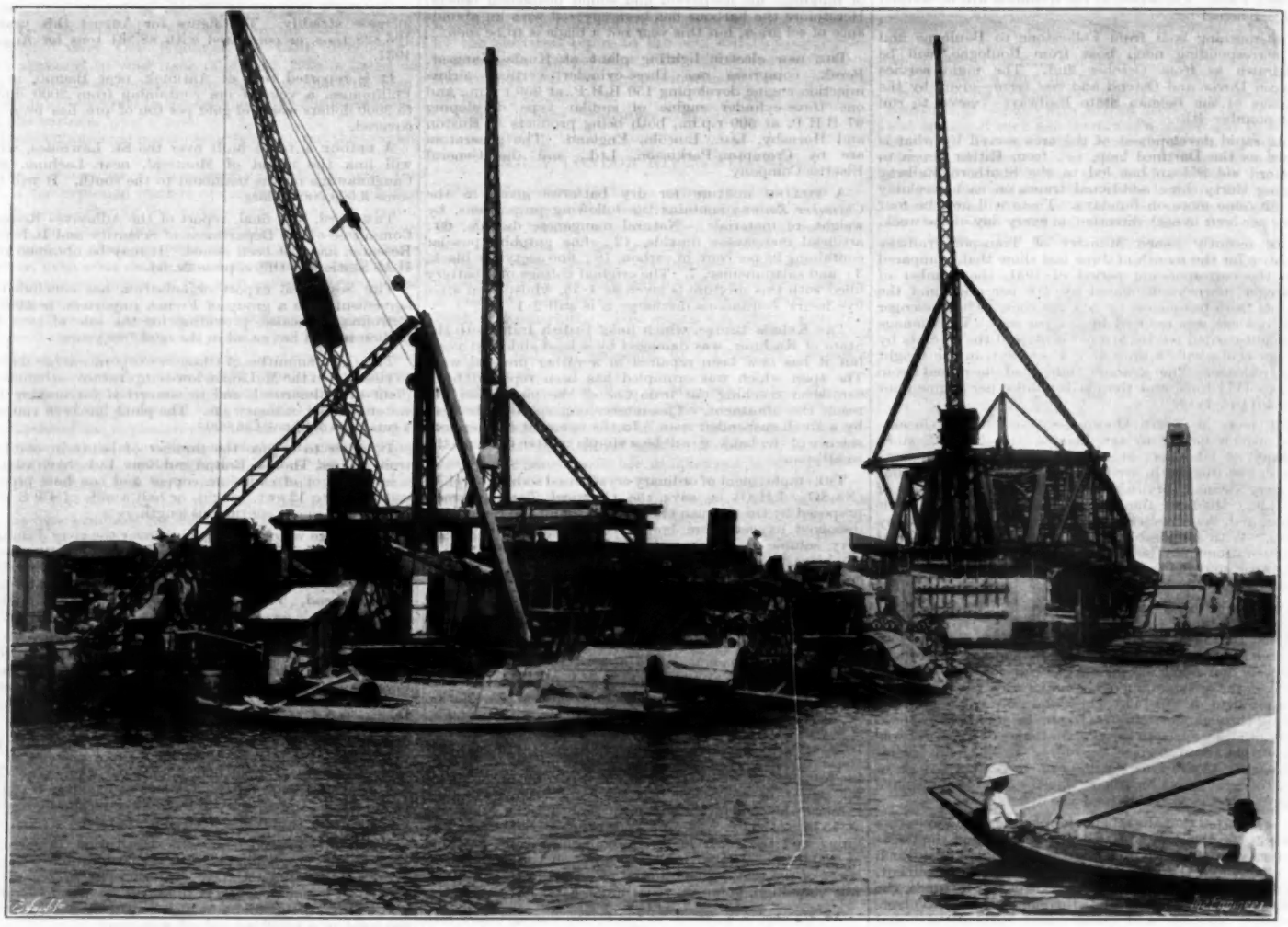


FIG. 7—SINKING OF THE WEST CAISSON AND ERECTION OF PIERS

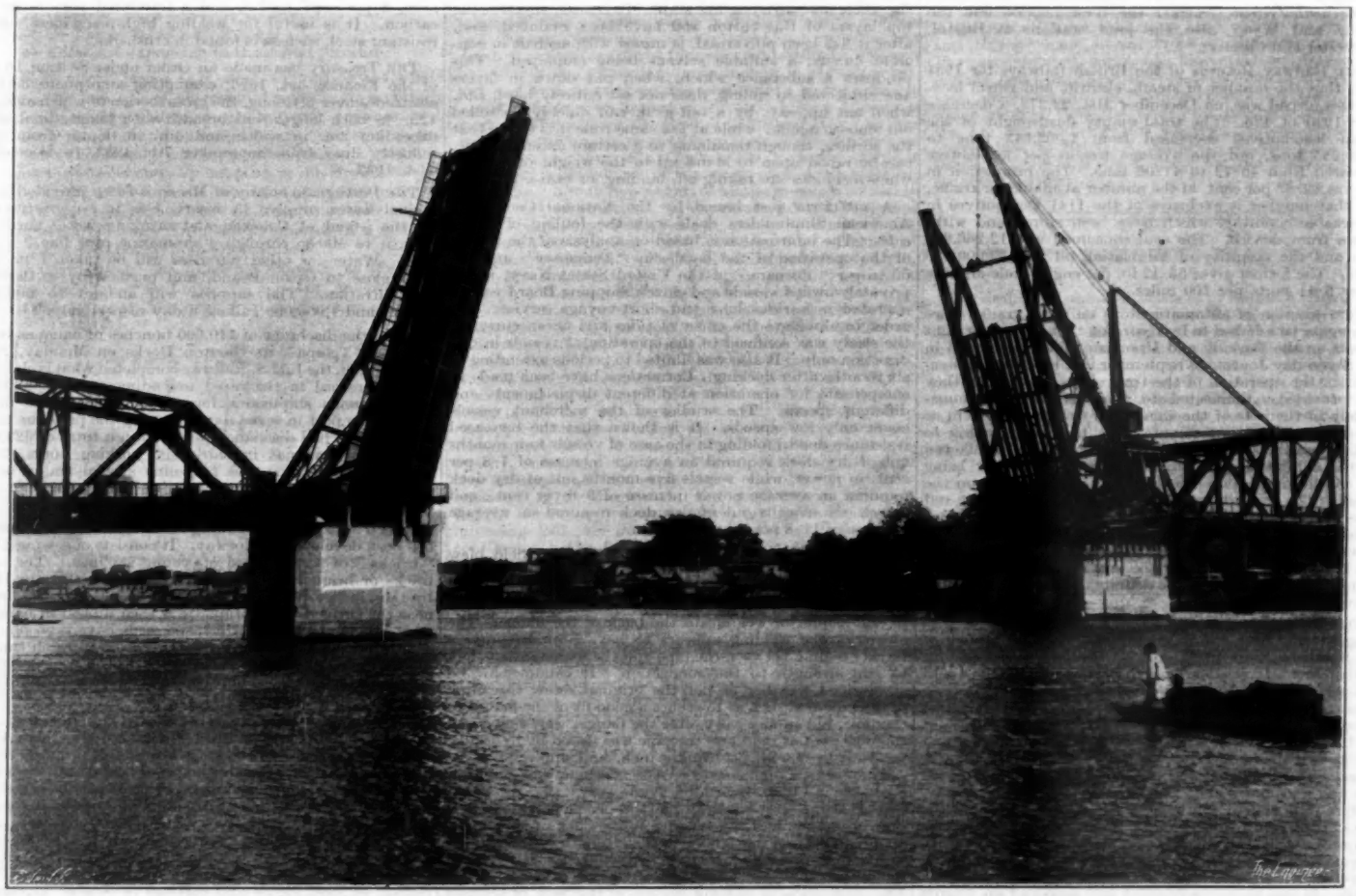


FIG. 8—ERECTION OF BASCULE SPAN

The Engineer

SEPTEMBER 16, 1932.

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NOTICES TO READERS.

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RAILWAY TRACTION.

WE regret that it is quite impossible to congratulate the British Association upon the debate on "Railway Traction," which was held before Section G. The opening monographs by Sir Seymour Tritton, on "Steam Power"; Sir Henry Fowler, on "Oil Engine Power"; and Mr. F. Lydall, on "Electric Power," were quite adequate for the purpose in view, the provocation of an effective discussion. But the result was disappointing. With the single exception of Sir Josiah Stamp, not a single speaker connected with railway management and operation took part, not a single C.M.E. had a word to say, the locomotive builders were represented by only two speakers, and the electrical industry by but one. When it is remembered that the railways all profess themselves to be deeply interested in the problems of traction, when we know that great efforts are being made to increase the economy of steam locomotives and that the advocates of the internal combustion engine are more active than ever before, and, finally, when we recall that the Weir report is still fresh in the mind, we cannot but feel surprised that so favourable an opportunity for debate met with such a poor welcome. We did not, indeed, dare to hope that anything new would be revealed at the meeting, but we did expect, not without reason, that the familiar arguments presented by the three protagonists would be controverted or amplified by subsequent speakers and that a useful general survey from which deduction might be drawn would result. Nothing of the kind happened; the discussion was not uninteresting, but it has left us just where we were and the problem is no nearer solution, by an inch, than before.

If one could draw any deduction whatever from the debate, it would be that the familiar steam locomotive is "digging itself in" more firmly than ever. Sir Josiah Stamp, who, first and foremost, is an economist, spoke strongly in its favour, and Sir Henry Fowler, who presented the case for the oil-engined locomotive, said nothing that would indicate his belief that it was likely to supplant steam in the near future. Mr. Merz, of course, championed electrification, but rather as something that must come in the future as the result of the electrification of the world than as something of economic necessity in the present. If anything, the internal combustion people put up a better case than the electric, but it is obvious that they are hampered by the high cost of their locomotives. Their spokesmen on various occasions have belittled the importance of prime cost and have demonstrated with much ability that, despite it, economy can be effected by employment of the oil-engined locomotive, but their arguments have not been powerful enough to move either British or foreign railways to any great extent, and, as we have remarked on other occasions, the problem they have still got to solve is that of a reduction of price. We do not suggest that it must be brought down to that of steam locomotives for similar service, but it must be something appreciably less than between two and two and a-half times as much. It is not always grasped, particularly by those who centre their attention on thermal efficiency, how completely all estimates of economy may be upset by high prime costs. That is true not only of all alternatives to the steam locomotive, but of all costly modifications of that type. Our best express engines consume about 3 lb. of coal per draw-bar horse-power per hour, and in a country like this, where coal is plentiful and cheap, that figure leaves relatively little possibility of saving to set against heavy capital costs. Hence it was that a railway economist like Sir Josiah Stamp was able, at York, to speak with satisfaction of the progress being made by steam locomotives which do not differ very greatly from their predecessors and are much cheaper than their younger rivals.

If the British Association discussion on this subject has made any clear impression, it must, we think, be that the steam locomotive is still firmly fixed for all classes of ordinary main line work in this country. That is not to say that it will remain indefinitely just as it is. Great improvements have been effected in the last twenty-five or thirty years and more remain to be made. Wonderful as it is, for its own service, the boiler still gives scope for the ingenuity of the inventor, whilst means of still further reducing the hammer blow are certain to be examined with the greatest care. But whilst steam, generated by the burning of coal, seems likely to hold its place in this country for many years to come—owing to ultimate economy and not, as some would have us believe, to the supineness of railway companies—other lands which are less well situated as regards fuel and water supplies should offer opportunities for makers of internal combustion locomotives, and we have good reasons for expecting and every hope that that industry, already well established in this country, will expand. In that expansion our own railways can play an important part. Service is the final test of a locomotive, and by continuing to extend to makers facilities for running new designs under ordinary operating conditions the railways of this country can be of invaluable assistance to manufacturers even if they themselves are not purchasers.

The Real Problem in Industrial Rationalisation

WE put at the head of this article a title which we think might fairly be given to the short Presidential Address which Commander C. W. Craven delivered to the Institute of Marine Engineers on Tuesday last. Rationalisation has been discussed to such an extent that we should all be as tired of it as we were some years ago of "Efficiency" were it not that few people know what it means. Commander Craven, however, unlike many of the talkers, is in a position to speak from inside knowledge and it is, therefore, of interest to consider what he regards as the "Real Problem" that has to be solved. Many have thought of rationalisation only from what may be described in general terms as the financial side. They have concerned themselves with the reduction of overheads, the removal of rivals, and the business advantages of co-operative efforts. These are the organisers of rationalisation schemes. On the other side are the sufferers—men displaced owing to the reductions of staff and the closing of factories, and those who cannot feel for a great amalgamation the same attachment and zeal that they had for a smaller, more individual company. Then there are those, a large body, who, whilst not belonging to the combine, have dealings with it and complain that the human touch has departed.

In the desire to make the best possible "business" out of rationalisation it would sometimes seem as if the financial side had been given an undue share of attention and that collateral effects on *personnel* had received but scanty sympathy. Hence, it is interesting to find Commander Craven describing what we may call the human side as the "Real Problem." "You cannot get away from the fact that the success or failure of any scheme depends on the personal qualities of those who have to put it into operation. Whatever the industry, whatever the form of grouping that may be selected, I am convinced that the financial fusing of the companies or firms under the professional guidance of lawyers, accountants, &c., is a very simple thing indeed, compared with the practical fusion of human beings who earn their living in the various component parts of the combine." We are confident that all engineers who have been connected with—we almost wrote entangled in—rationalisation schemes will endorse these views, but they will welcome them as coming from one in Commander Craven's position. For, whilst they are almost truisms to all who have to carry out the practical duties of management, they are not, we fear, as fully appreciated by those who only look to the results and have not to concern themselves with how they are obtained. It is a fact which, perhaps, has not always received full consideration, that rationalisation, in its modern dress, is a device for getting out of difficulties. Probably the word would never have been invented if business had remained good. When there was work and enough to go round, when rivalry was never pushed to the extremity, and "cut-throat" competition was rare rather than common, individualism with its manifest advantages flourished. Employers knew their men personally, and what was of equal importance they knew their customers well, too. Transactions were frequently enacted on what is called a gentleman's contract, and the works took as keen an interest in the success of their firm as the owners and managers. Taken for all in all, it is doubtful if an industrial world can be run on better lines. But one thing and another destroyed the old system and the adoption of rationalisation, to a greater or less degree, was forced upon most industries in order to avoid excessive overhead costs and the reckless cutting of prices. The point we want to make is that it has come in not as the best that is possible—save from the financial view—but as the only means of meeting adverse conditions. Hence, it is that hardships accompany it, that men in good positions are discharged after long years of service, works are closed, and employees dismissed. Unfortunately, these effects coincide with indifferent industrial conditions with the consequence that unemployment results. Were it not for that fact it is probable that rationalisation would have fewer enemies than it has to-day. But it has come and we have to make the best of it. That, we believe, can be attained by preserving as far as possible the better qualities of individualism, amongst which must certainly be placed the personal touch, not only with employees of all grades, but with the purchaser as well. "There is no doubt," says Commander Craven, "that, in theory, both Capital and Labour should benefit by proper rationalisation of competing undertakings, where economies can be effected by the fusion of manufacturing interests and reduction in administrative and selling expenses, but danger lies ahead unless those responsible for putting the rationalisation into practice look further than the paper estimates of saving which can be made." We fear that in some cases rationalisation has been carried out without this long view, and has resulted in the adoption of a system which is good neither from the business nor the humane point of view.

Whilst Commander Craven's words seem to apply to the *personnel* of the manufacturing side, we have no doubt that he is amongst the first to recognise that unless the selling side has, also, its personality the results will fail to reach complete achievement. That is an aspect of rationalisation which, we suspect, has, even now, not received proper consideration. One cannot deny that as businesses grow in magnitude personal touch between the purchaser and the manufacturer decreases. The latter hands the "goods" to the customer across the counter and takes no further interest in them. We may contrast that behaviour with the method of, say, some machine tool firms—all relatively small—which maintain touch with the machines they sell till they are worn out or replaced. "Hitherto," wrote Mr. Fred Clements in a remarkable series of four articles on the "British Steel Industry" which have been just reprinted by *The Times Trade and Engineering Supplement*, "hitherto, in much too large a degree, steel has been supplied to a customer, and the steel maker has shown no further interest

as to whether the material was that best suited to the requirements of the customer." In the steel industry rationalisation has gone as far as in any and it is a good sign that, through one of its leading spokesmen, it shows recognition of the value of a closer personal touch between the manufacturer and the purchaser. That touch cannot be effectively maintained unless there are personalities on the commercial staff of the manufacturing firm who are competent to carry out what must often be delicate negotiations. And so we come back to Commander Craven's contention that *the* problem of rationalisation is the "personal qualities of those who have to put it into operation."

Electricity Supply in Great Britain.

THE return of engineering and financial statistics relating to authorised electricity undertakings in Great Britain for the year ending March 31st, 1931, or May 15th, 1931, for public authority undertakings, and December 31st, 1930, for company undertakings, follows the general form of previous returns, and is divided into two sections, namely, "Engineering" and "Financial." The stage of development attained by the public supply undertakings in Great Britain in 1930–31 was represented by the following average figures per head of estimated population in 1930, namely, a connected load of approximately 288 watts, a maximum demand of about 105 watts, and the sale to consumers of 203 units per annum. At the end of 1930–31 there were approximately 4,015,000 consumers of electricity connected to the public supply systems throughout the country.

Of the total supply of electricity by authorised undertakings, nearly two-thirds were provided by public authorities and upwards of one-third by companies, these proportions broadly applying to the aggregate capacity of the generating plant installed by the respective groups of undertakers, to output and sales of electrical energy, and to capital expenditure.

The production of the public supply in 1930–31 involved the operation by authorised undertakings of as many as 483 generating stations, containing in the aggregate about 6,945,800 kW of generating plant, upwards of 76 per cent. of which was contained in 94 stations, each having an installed capacity of 25,000 kW or over, and 24 per cent. was distributed among the remaining 389 stations, of which 197 had an installed capacity of less than 1000 kW each. Of the total generating plant installed, 96 per cent. was of the A.C. type working at eleven different frequencies. Over 82 per cent. of all the A.C. plant, however, was of the accepted standard frequency of 50 cycles per second, the two predominating non-standard frequencies of 25 and 40 cycles per second accounting for 11 and 5 per cent. respectively. During the year 1930–31 a net addition of about 346,000 kW was made to the plant capacity of the authorised undertakings. Further progress was made in the equipment of generating stations with large modern units of plant, and at the end of 1930–31 over 57 per cent. of all the generating plant installed consisted of steam turbo-alternator units having capacities of 10,000 kW or over. As regards boiler plant, the statistics disclose the continuing tendency to adopt larger units and higher working pressures.

The particulars relating to the distribution systems of public supply undertakings show that A.C. supplies of thirteen different frequencies were being distributed in 1930–31, and that the declared voltages at consumers' terminals for low and medium pressure A.C. and D.C. supplies taken collectively numbered 45, including related pairs of voltages on three-wire and four-wire systems. Over 81 per cent. of the total public supply was sold to the consumers, the remaining 19 per cent. being accounted for by the works requirements of the undertakings and by losses in transmission, distribution, &c. Power supplies accounted for about 59 per cent., lighting and domestic supplies for 30 per cent., and traction supplies for about 9 per cent. of the total units sold to consumers. The sales of electrical energy for lighting and domestic purposes increased by 400 million units, while the sales for power purposes showed a decrease of 37 million units. During the year there was an increase of upwards of 543,000, or over 15 per cent., in the number of consumers of electricity. Inter-sales of energy in bulk between authorised undertakings for ultimate distribution to consumers accounted for 25·8 per cent. of the total public supply, as compared with 22·6 per cent. in the previous year.

The combined maximum load on the public supply undertakings in 1930–31, based on units generated and/or purchased, was in the neighbourhood of 4,700,000 kW, and that on the generating stations of authorised undertakings about 3,801,000 kW. The capacity of generating plant installed was nearly 83 per cent. in excess of the combined maximum demand upon it. The load factor of the generating stations of public authorities and companies was in the neighbourhood of 31 per cent. and 36 per cent. respectively, the combined figure being about 33 per cent.

The statistics indicate that economies continue to be effected in the utilisation of fuel at steam-driven generating stations. Public supply undertakings were consumers of coal and coke to the extent of over 8,685,000 tons in 1930–31, the figure including over 941,000 tons of pulverised fuel. The average cost of the coal and coke amounted to 15s. 11d. per ton, as compared with 15s. 5d. in 1929–30.

The total expenditure charged to capital account by authorised undertakings amounted at the end of 1930–31 to over £354,000,000, of which about 38 per cent. was in respect of generation and 62 per cent. in respect of transmission, distribution, &c. The average expenditure for all purposes per kW of generating plant installed was over £51. The net capital expenditure during the year 1930–31 amounted to upwards of £27,000,000, an increase of over 8 per cent. on the total expenditure at the end of 1929–30. The total revenue from the working of all authorised undertakings was £63,469,000, as compared with £59,711,000 in the previous year. The total revenue represented an average of 1·27d. per unit sold, the corresponding figure for the previous year being 1·29d. The average revenue per £100 of capital expenditure amounted to £17·9, this figure being reduced to £15·9 if revenue from the intersale of energy in bulk between authorised undertakers is excluded.

Literature.

SHORT NOTICES.

Thermionic Emission. By Dr. W. S. Stiles. London: H.M. Stationery Office. Price 2s. 6d. net.—Fundamental research into the physics of thermionic emission forms the basis from which the modern radio valve has been evolved, and a knowledge of this work is essential to those interested in the practical development of valves. Although the literature on the subject is extensive, it is widely scattered in journals published throughout the world, and with the object of facilitating further research and development the Radio Research Board has arranged for the issue of this special report, which gives a comprehensive survey of all the main results obtained in researches in the various branches of the subject, together with a lengthy bibliography, which includes references to all the important papers published up to December, 1930. The report has been prepared at the National Physical Laboratory by Dr. W. S. Stiles, who has tackled the task in a very able manner.

Pulverised Fuel Firing. By S. H. North. London: Sir Isaac Pitman and Sons. 1932. 7s. 6d.—In his preface the author says that developments point to the probability that pulverised fuel will during the next few years witness a very great extension of its application; hence, it is well that engineers should be *au fait* with the present state of the art of burning powdered coal. The author is obviously in favour of pulverised fuel, and puts forward its advantages conclusively and in clear language. He covers the whole range of furnaces, from those of big water-tube boilers, to those of Lancashire boilers and for metallurgical work, describing the whole of the plant necessary and giving examples of performances. It is a concise little book, giving one side of the problem of combustion, but no one could describe it as biassed.

A Concise Building Encyclopædia. Compiled by T. Corkill, M.I. Struct. E. London: Sir Isaac Pitman and Sons, Ltd., Parker-street, Kingsway, W.C.2.—In compiling this little volume the author has provided the building and constructional trades with a handy and concise dictionary of terms, some 7000 of which are explained and in many cases illustrated. To keep the book within reasonable limits, the names of familiar tools and appliances have been omitted. Some of the uncommon local terms used in various parts of the country are dealt with.

BOOKS RECEIVED.

Memorandum on Accident Prevention. London: Industrial Welfare Society, Inc., 51, Palace-street, S.W.1.

Tunnard's Tanker Tables. By B. Tunnard. Glasgow: Brown, Son, Ferguson, Ltd., 52–58, Darnley-street. Price 7s. 6d. net.

Ordnance Survey: Relevelling of London: Abstracts of Secondary Series, 1932. Southampton: Ordnance Survey Office. 7s. 6d. net.

Manual of Military Motor Cycles, 1932. London: His Majesty's Stationery Office, Adastral House, Kingsway, W.C.2. Price 2s. 6d. net.

Rebeiro's Train Resistance Charts. By G. Rebeiro, B.A. London: Locomotive Publishing Company, Ltd., 3, Amen Corner, E.C.4. Price 5s. net.

Modern Radio Communication. Fourth edition. By J. H. Reyner. London: Sir Isaac Pitman and Sons, Ltd., Parker-street, Kingsway, W.C.2. Price 5s. net.

Ripper's Steam Engine Theory and Practice. Eighth edition. By W. J. Goudie, D.Sc., &c. London: Longmans, Green and Co., Ltd., 39, Paternoster-row, E.C.4. Price 25s. net.

The Exponential and Hyperbolic Functions and their Applications. By A. H. Bell, B.Sc., &c. London: Sir Isaac Pitman and Sons, Ltd., Parker-street, Kingsway, W.C.2. Price 3s. 6d. net.

Civil Engineering Specifications and Quantities. Second edition. By G. S. Coleman, D.Sc., &c., and G. M. Flood, B.Sc., &c. London: Longmans, Green and Co., Ltd., 39, Paternoster-row, E.C.4. Price 12s. 6d. net.

Corrosion-Fatigue of Metals.

By H. J. GOUGH, M.B.E., D.Sc., Ph.D., Member.

INTRODUCTORY.

CORROSION being essentially a process of oxidation, and fatigue a generic term employed to denote those phenomena exhibited by metals and other materials, when subjected to cyclical variations of stress, the subject of the present lecture may be properly and concisely defined as the behaviour of metals subjected to cyclical stresses while exposed to an environment of an oxidising nature. Objections have been raised to the use of the term "corrosion-fatigue" on the grounds that undue restrictions are thereby placed on the range of the phenomena which fall within the meaning of the term, but these objections are fallacious, apparently being based on the assumption that fatigue occurs only when the applied conditions are such that complete fracture will ultimately result. This definition of fatigue is much too restrictive, for extensive researches have shown that, under certain conditions, metals can be exposed to an indefinitely great number of repetitions of a range of cyclic stress without producing fracture, although the physical properties of the metal may be greatly changed in the process. These changes are indications of fatigue. Corrosion-fatigue of metals will therefore be discussed according to the definition stated above.

Much confusion has resulted from a tendency to consider "fatigue" and "corrosion-fatigue" as separate and distinct actions. A correct appreciation can be obtained only if the whole subject is treated on a perfectly general basis under one general title. It cannot be denied that the term "fatigue" is open to grave criticism, but it has acquired universal use.

CORROSION-FATIGUE FAILURES IN SERVICE AND UNDER LABORATORY CONDITIONS.

Corrosion-fatigue is the direct cause of a large variety of failures in service, although until fairly recently the potency of the combined effects of corrosion and cyclic stress, also various characteristics of such failures, have been so little understood that their cause has often remained obscure and unappreciated. As would be expected, this type of failure is common under marine conditions, and precautions, such as the sheathing of propeller shafts with bronze liners and means of preventing sea water from entering joints, were common practice long before the principles governing corrosion-fatigue were realised. In those earlier times, what was aimed at chiefly was undoubtedly the prevention of the wastage of metal and its resulting decrease of effective resistance by mere reduction of dimensions, and it must have been a complete mystery how total failure occurred with such a slight degree of apparent surface damage. The particularly destructive mechanism of corrosion-fatigue, by which very sharp, narrow fissures are formed, is now becoming more generally known, and the mystery no longer remains.

From careful examination of certain boiler explosions and similar failures, McAdam believes that these failures may be regarded as extreme cases of corrosion-fatigue, in which the cyclic stresses are of such extremely low frequency that the fatigue or final stage is practically absent. A great difference exists between boiler conditions and those of ordinary corrosion-fatigue, but McAdam concludes that laboratory tests made in cold water and at low cyclic frequencies give considerable support to his view. It may be noted that tests made at Illinois have shown, as would be expected, that boiler feed water, so treated as to prevent caustic embrittlement, causes corrosion-fatigue in laboratory specimens of boiler material. The possible connection between boiler failure and corrosion-fatigue is receiving some attention at the National Physical Laboratory at the present time.

Conditions which tend to promote failure by corrosion-fatigue are imposed on water-cooled piston-rods of internal combustion engines, and many failures have occurred in service. The alternating stresses are two-fold, due to the piston and crank shaft loads and centrifugal force, also to the stresses caused by the cyclic changes in temperature.

In some cases the surfaces exposed to a corrosive agent have suffered damage by general corrosion, but the loss of strength due to mere reduction of dimensions is of a negligible order compared with the actual damage caused by the formation of sharp pits under corrosion-fatigue conditions. It is unnecessary to discuss in detail the failure of corrosion-fatigue specimens tested in the laboratory. The same general characteristics observed on service failures are exhibited in laboratory specimens, with the difference that in such specimens the surface corrosion is usually much less evident. This is due to the shorter total life of most laboratory specimens, owing to the high cyclic speeds usually employed for testing purposes. The actual amount of surface corrosion observed will naturally depend on the test environment and on the metal under test. Ordinary steels tested in tap water show slight surface rusting. In strongly saline solutions the rusting is, naturally, more pronounced. Materials such as stainless steels and nitrided steels often show no signs whatever of

* Eleventh Autumn Lecture to the Institute of Metals delivered September 12th, 1932. Greatly abridged.

surface rusting, although the fatigue strength has been reduced considerably by subjection to a salt spray. Even where the surface of a specimen becomes heavily coated with corrosion products, examination usually shows that the amount of general surface corrosion has been extremely small and that the diameter of the specimen has not been sensibly reduced; extremely corrodible metals like magnesium alloys are exceptions. It is usual, in failed corrosion-fatigue specimens, as in service fractures, to find that, in addition to the main fracture, a large number of other cracks is present. This is a characteristic not usually observed in ordinary fatigue failure.

A further point may justify a word of explanation. To those unacquainted with fatigue phenomena it may appear strange that, if corrosion-fatigue failure is essentially a surface pitting effect, large service failures and small laboratory specimens should exhibit such similar lack of resistance to corrosion-fatigue destruction; in other words, a scale effect might be expected. It must be remembered, however, that the stress concentration due to a sharp pit is controlled primarily by the shape of the pit, and not by its dimensions. Similarly shaped pits in large and small sections, if of sufficient "sharpness," would all tend to start a progressive fatigue crack, even though it might take longer for complete fracture to occur in the larger section. McAdam has, in fact, shown experimentally that the resistance to corrosion-fatigue of specimens of diameters from 0·5in. to 2·5in. is practically independent of the actual diameter, and we may safely infer that no scale effect exists for much greater sizes. To avoid any possible misunderstanding, however, it must be mentioned that severe pitting often results from exposure to the corrosive environment, irrespective of whether cyclic stress is or is not applied. In the case of very thin sections, therefore, this pitting due to "stressless corrosion" may reduce the fatigue resistance practically to zero value; hence, such a section would appear to disadvantage when compared with thicker sections, but this is not a scale effect in the sense of the above remarks.

It has been pointed out that because of the many important operative variables—corrosivity of environment, method and speed of test, type of stressing action, &c.—which control the resistance of a metal or alloy to corrosion-fatigue, it is quite futile to attempt to express this resistance as a simple numerical quantity. If, however, a wide range of materials is investigated, employing some selected set of test conditions, certain valuable broad conclusions can be reached regarding the influence of chemical composition, heat treatment, and cold working. (It must not be assumed, *a priori*, that these conclusions will apply equally to any other set of conditions for the same materials.)

From detailed consideration of available data emerge the following general conclusions regarding the effect of chemical composition, heat treatment, and cold working on the resistance to corrosion-fatigue. With any particular metal or alloy the corrosion-fatigue properties will depend primarily on the resistance of the alloy to corrosion in the particular environment under the conditions of tests. The maximum resistance of the alloy to corrosion-fatigue will be exhibited when the material is in the most favourable condition to resist corrosion. Other forms of heat treatment and cold working in general, although causing wide variations in other mechanical properties, will not effect any improvement in the corrosion-fatigue resistance, but may be extremely harmful, especially if internal stresses or discontinuities in the material are set up by the treatment or cold work. Improvement will result from a change in chemical composition only provided that the change confers increased resistance to corrosion under the particular environment.

In applying the results of the study of net damage to practice, two points are of special interest. Attention may be directed to the serious effect of low stress ranges on corrosion pitting at low frequencies, even with alloys which are very resistant to stressless corrosion. Engineering components which exhibit little visible signs of general corrosion may therefore fail by the formation of local deep and sharp pits. McAdam, after careful study of various boiler failures, concluded that many of these were directly attributable to the effects of corrosion pitting under stress cycles of small range and extremely low frequency. The second interesting fact is that the relative corrosion-fatigue resistances offered by the same metal exposed to two different environments of varying corrosivity may be completely altered by a change in cyclic frequency.

Corrosion-Fatigue in Steam.

The behaviour of metals when subjected to alternating stresses in an atmosphere of steam is an aspect of corrosion-fatigue which is of considerable practical importance in connection with steam power production. It also possesses theoretical interest as demonstrating that the fundamental characteristics of corrosion-fatigue, in steam as in other environments, are controlled by the same primary factors. This aspect of the subject has received some experimental attention by several investigators. The most systematic investigation of which the author is aware is that carried out by Fuller, who determined the endurance properties, in air and in steam under various conditions of temperature and pressure, of materials commonly used in turbine construction.

The results demonstrate the practical importance of using pure dry steam in turbines and the advantages obtaining from the use of suitable water treatment and thorough de-aeration. They bring out clearly the destructive effects produced by the presence of liquid water and of oxygen in steam. The results direct attention to the general factors which are of importance in corrosion-fatigue, whatever the particular environment may be. For example, 3·5 per cent. nickel steel and stainless iron, when exposed to a jet of steam in air, as in Fuller's tests, exhibit practically the same resistance to corrosion-fatigue as when tested in a stream of water in air, as in McAdam's tests, showing that the oxygen supply is the factor of chief importance. Fuller mentions that exposure to a jet of high-velocity moist air, while subjected to cyclic stress, reduces the fatigue resistance to the same value as when subjected to a stream of tap water in air. On the other hand, H. F. Moore mentions tests made at Illinois University on an alloy steel, in which the action of a jet of wet steam reduced the fatigue resistance to a value intermediate between the fatigue limit in air and the corrosion-fatigue limit (2×10^7) obtained in a stream of tap water in air.

Owing to the kindness of Dr. E. Honegger, and of the firm concerned, the author is able to refer to some unpublished tests which Dr. Honneger has carried out at the works of Messrs. Brown, Boveri and Co., at Baden. The material tested was 3–3·5 per cent. nickel-steel (tensile strength, 85,000–92,000 lb. per square inch) used for steam turbine blades. The material was taken from various batches, although all bought to the same specification, and hence some "scattering" of results was obtained. These lay, however, within limiting values which are fairly clearly defined. The data relate to rotating beam tests in which a constant bending moment was applied over the whole length of the specimen. The tests were extremely lengthy, extending up to 200 millions of stress reversals, at which stage the S/N curves had all become nearly parallel to the N axis. The results obtained are given in Table I.

Table I.

Condition.	Fatigue limit, lb per sq. in. (2×10^8). Limits.	Average.
In air In air (chromium-plated) In hot water at 100° C. In air, specimen covered with film of oil	46,000–40,000	43,000
In atmosphere of dry saturated steam at 100° C.	34,000–26,000	30,000
In atmosphere of dry saturated steam at 100° C. (chromium plated)	32,000–23,000	27,500
In water stream	23,000–18,000	20,500
In water stream (chromium plated)	25,000	25,000

A film of oil or chromium plating has not affected the fatigue limit in air, whilst the hot water test shows that the "temperature" effect of the steam can be neglected. The corrosion-fatigue limit (2×10^8) in steam has a value intermediate between that of the fatigue limit in air and the corrosion-fatigue limit (2×10^8) in water. Little, if any, improvement was afforded by chromium plating in the steam or water tests. This, however, may have been caused by faults (discontinuities, internal stresses, &c.) in the actual coating employed.

The above experiments appear to the author to indicate that, provided the broad facts of the problem are appreciated, failure by corrosion-fatigue should not be a source of anxiety in connection with turbine plant that has been carefully designed and is properly maintained.

Corrosion Accelerators and Inhibitors.

Laboratory researches into corrosion-fatigue usually involve experiments in which the uniformity of the environment is carefully controlled and maintained within close limits. It has previously been shown that the resistance of a metal to corrosion-fatigue depends much more on the corrodibility of that metal in relation to its particular environment than on the physical and mechanical properties of the metal. Hence, it is impossible to assign to a metal for all conditions any such definite property as a "corrosion-fatigue limit." It is essential to recognise that small local variations in the environment or condition of the surface of the metal may produce effects which are far greater in magnitude than those resulting in circumstances from which such local variations are absent, although the general or average conditions of corrosion and stress remain unchanged. Local variations of concentration of the corrosive agent or of the oxygen supply in the environment assume great importance, also non-uniformity in the surface condition of the metal itself. Thus, a discontinuous coating of protective material is generally more harmful than if the coating had been omitted entirely. Local variations producing destructive effects may be termed corrosion accelerators. Again, although in the future considerable reliance may be placed on protective coatings to reduce corrosion-fatigue, many cases occur where the use of corrosion inhibitors offer considerable advantages.

Experiments of Speller, McCorkle, and Mumma provide very interesting data relating to corrosion inhibitors. They are even more valuable in emphasising the importance, in corrosion-fatigue phenomena, of small local differences of conditions, the effects of which may be much more destructive than those of the general environment. Their publication directed attention to the direct link which exists between the fundamentals of stressless corrosion and the essential characteristics of corrosion-fatigue. Previously, many of those interested in the latter subject had been somewhat inclined to interpret the results entirely in "mechanical" terms, giving consideration mainly to the stress concentrations set up at the bottom of corrosion pits. Important these undoubtedly are, but corrosion-fatigue phenomena are incomprehensible until the problem is considered from the aspect of the formation and stability, repair, penetration by diffusion, or breakdown, of surface films. Also the essential differences between stressless corrosion and corrosion-fatigue are difficult to reconcile until the effect of cyclic strain on the film is considered.

The Importance of Oxygen as a Factor in Fatigue.

"Corrosion-fatigue" and "fatigue" are terms usually applied to distinguish between two groups of phenomena which are often regarded as essentially different in nature, although possessing many features in common. Yet, although this division is useful and generally practicable, it cannot be justified on any scientific grounds, as will become apparent if attempts are made to prepare discriminative definitions. Much too careless a use is made of the type of "definition," such as, for example, "that corrosion fatigue is in operation when a metal is exposed to an agent of a corrosive nature and subjected simultaneously to alternating stresses, resulting in destructive effects greater than those obtained when either action is operating alone." Many experiments are on record the results of which are incomprehensible when considered in this way. Again, if the term "fatigue" is to be restricted to the fracture of metals under alternating stresses in an environment entirely devoid of corrosive substances, it becomes open to doubt if many real fatigue tests have ever been made. Certainly, the usual type of test made in air cannot be placed definitely in this class, as air must be considered as of a corrosive nature, however mild. A useful insight into the importance of this aspect of the subject will be obtained if some critical consideration is given to various unrelated experimental results selected from the literature.

Very curious and apparently contradictory results, obtained quite independently, become intelligible and consistent if we assume that atmospheric oxygen is a factor in ordinary fatigue tests, but the results themselves offer evidence only of an indirect nature on this point. Tests made *in vacuo* or in atmospheres of inert gases were obviously required to give direct evidence. Such tests are in progress at the National Physical Laboratory, and some results are now available. Gough and Sopwith have determined the fatigue limits, under reversed direct stresses, of a range of materials tested (*a*) in air, and (*b*) in a partial vacuum in which the air pressure was not greater than 10^{-3} mm. of mercury.

The fatigue limits marked thus * in Table II. represent average values as some "scatter" of results was obtained. The effect of the partial vacuum was therefore not clearly established. From the other tests, it is evident that the atmosphere definitely affects the fatigue resistance. The effect on steels is but slight, as a 5 per cent. increase in fatigue limit *in vacuo* is the maximum recorded. The magnesium alloy appears to be unaffected by the change of environment. Copper and brass, however, show increases of no less than 14 per cent. and 26 per cent. respectively, the latter being a really remarkable improvement.

Table II.

Material.	Fatigue limits, tons per sq. in. In air.	In partial vacuum.	Ratio, fatigue limit in vacuum/fatigue limit in air.
0·5% carbon steel (cold rolled)	±21½*	±22½	1·03
Stainless steel (Cr 15, C 0·12%)	±22	±22½	1·01
Stainless steel (Cr 18, Ni 8, C 0·1%)	±24½*	±24½	0·98
Stainless steel (Cr 17, Ni 1, C 0·25%)	±28½	±28½	1·00
Duralumin	± 7½*	± 8½	1·06
Magnesium alloy (Al 2·5%)	± 5½	± 5½	1·00
0·13% carbon steel	±13·0	±13·7	1·05
Copper (99·96%) annealed	± 4·3	± 4·9	1·14
Brass (70 : 30) annealed	± 7·2	± 9·1	1·26

It is possible that the use of higher degrees of *vacua* may reveal even greater increases in the fatigue limits of the same materials, also other materials may be even more sensitive to atmospheric corrosion. In future, the fatigue resistance of a metal, as determined *in vacuo*, should be regarded as the real standard of comparison. If any other environment is used, the fatigue resistance may be equal to, or less than, this optimum value, but it is reasonable to suppose that—apart from temperature effects—it cannot be greater, although in certain circumstances the value

obtained may exceed the endurance limit when tested in air.

Corrosion-Fatigue Phenomena as Exhibited by Changes of Microstructure.

When one recalls the valuable additions that have been made by the aid of the metallurgical microscope to the knowledge and understanding of the mechanism of the deformation and fracture of metals, it is somewhat surprising to find that such limited attention has hitherto been given to the changes in micro-structure occurring during corrosion-fatigue. It is, however, a fact that no systematic study has yet been made in this direction. As a result, little information exists on such fundamental points as (1) the actual point of initiation of a corrosion-fatigue crack, whether it is situated at a crystal boundary or on the site of previous slip bands or at local corrosion pits bearing no distinct relation to these special positions; (2) the general course of a crack, whether intercrystalline or transcrystalline; and (3) whether the existence of a "corrosion-fatigue limit" receives support from visual observations. Systematic researches are in progress on these aspects in at least one laboratory at the present time, although the results are not yet fully available.

The Mechanism of Corrosion-Fatigue.

The time has not yet arrived at which attempts to formulate a theory of the failure of metals by corrosion-fatigue can hope to meet with success. The complex laws governing corrosion phenomena do not appear to be thoroughly understood. Similarly, a fundamental theory of fatigue has yet to be evolved. Nevertheless, by availing ourselves of those interpretations of the characteristics of corrosion and fatigue which have obtained general acceptance, it is possible to deduce a useful working conception of the combined process. A typical case of corrosion-fatigue will be discussed—namely, a specimen subjected to a constant range of applied loading (less in magnitude than that required to produce fracture when the test is made *in vacuo*), whilst simultaneously exposed to a stream of liquid of a corrosive nature (say, a neutral salt solution), saturated with oxygen.

The history of the specimen can first be divided into two main periods. During the first stage of corrosion-fatigue damage is done to the specimen resulting in a condition (by pitting, crack formation, wastage, &c.), such that if the corrosive environment is removed altogether, fracture due to the cyclic stresses will result ultimately by the process of a spreading crack or cracks. Thus what will be termed the second stage of the history is essentially a "fatigue" stage, in which failure proceeds according to the general laws of fatigue, the most important characteristic feature of which is the propagation under the applied cyclic stresses of a crack or flaw by stress concentration effects, the magnitude of which is controlled primarily by the shape of the flaw or crack and the physical properties of the material under test. These characteristics of failure by a spreading crack have received much detailed study, using the metallurgical microscope. They are well understood and require no comment. In discussing the first stage—during which the effects of corrosion and cyclic stress are in operation—it will be helpful to consider separately the effect of the maximum stress of the cycle (as a static stress), and then consider how this effect is modified by the range of strain associated with the cyclic stresses.

The type of corrosion-fatigue in which we are primarily interested—namely, industrial metals and alloys in nearly neutral solutions—essentially requires the presence of oxygen. While the simple process of direct chemical union of the oxygen with the metal cannot be altogether excluded, the general effect of such an action is relatively small. The much greater order of damage usually sustained in corrosion-fatigue, also the nature of the damage (by a process of deep local burrowing), indicates unmistakably that a process of electro-chemical corrosion is in operation. A characteristic of this type of corrosion is a lack of uniformity* in conditions, either internal or external to the metal. But the various causes of non-uniformity within the metal are capable of setting up electro-chemical actions, but of such a small order as are not likely to produce the gross damage often observed in corrosion-fatigue. We also deduce that corrosion is not likely to be accelerated by the presence of elastic stress.

The marked destructive effects in corrosion-fatigue are probably governed by two primary factors—(*a*) unequal distribution of oxygen, and (*b*) behaviour of protective films. It will be realised that the essential problem of corrosion-fatigue is to explain why such severe local damage is caused while the general wastage of the specimen is often inappreciable. Visual and miscroscopical evidence shows that failure usually occurs by a process of deep "burrowing" into the metal of sharp crevices, and it is important to find an adequate explanation of the mechanism of this burrowing. Possibly, the differential aeration theory of Aston and Evans and the knowledge of the properties of protective films made available by the brilliant work of Bengough, Vernon, and Evans, when considered in relation to known fatigue phenomena, may supply the required explanation.

Thus existing theories of corrosion adequately account for the particularly destructive type of penetration which is observed in corrosion-fatigue, and if it can be explained why penetration continues to operate, the observed final failure becomes inevitable. But the same mechanism of corrosion obtains during static corrosion, where the action ceases after a time in some cases, and in others continues at a much slower rate. How, then, is the much more rapid action which occurs under corrosion-fatigue to be explained? In the first place, knowledge of fatigue phenomena enables us to say with certainty that once a certain shape of discontinuity of surface has been formed by corrosion or other means, then the mechanical stress concentrations induced become much more effective in producing failure under the action of applied alternating stresses than when static stresses only are in operation. For example, it is well known that the presence of a V-shaped discontinuity may produce an actual increase in tensile strength, whilst the same shape will result in a considerable decrease in fatigue strength. Further, the decreased fatigue resistance is largely independent of the actual dimensions of the discontinuity, and is controlled mainly by its shape. These facts are incontrovertible, and stress concentration effects also enter largely into corrosion-fatigue phenomena, but they are inadequate to account for the vastly increased velocity of corrosion under corrosion-fatigue conditions. The author considers that this increased velocity is largely due to the effect of the cyclic strains on the porosity and rupture of the protective (wholly or weakly) films that tend to form under corrosion conditions. The thickness of the film is so small that its strength cannot enter into the problem. Its range of strain will be determined entirely by the severity of the stresses induced in the metal and by the stress-strain relations of the latter. Should the nature of the metal with respect to its environment be such that a flexible, adherent, and continuous protective film is normally formed, then the degree of protection afforded under corrosion-fatigue would appear to depend on the effect of the cyclic strains imposed on the film on its permeability and freedom from rupture. Another view is offered by McAdam, who considers that the corrodibility of the metal is directly increased by the cyclic stresses, although he does not exclude altogether from consideration the effect on the film.

To sum up, it may be said that the principal phenomena produced under corrosion-fatigue conditions become comprehensible immediately it is recognised that the main problem is one of corrosion and that the same primary factors are involved. In both groups of phenomena, protection against damage depends essentially on the formation and behaviour of a protective film, also internal or external conditions which tend to set up electro-chemical effects will exert considerable influence in disturbing these films. Partial or complete protection can be afforded either by increasing the corrosion resistance of the metal by suitable chemical composition or by passifying the metal in relation to its environment, bearing in mind, however, that local conditions tending to increase corrosion effects may be more damaging than general corrosion. The author considers that it is very doubtful whether stress, as such, is an important factor in corrosion-fatigue. It becomes clear why a series of alloys—such as the plain carbon steels—does not exhibit widely different resistances to corrosion-fatigue, if the chemical constituent, the proportion of which is varied within the range, does not influence appreciably their corrosion resistance. Similarly, the effects of heat treatment and cold work will be very small when compared with their influence on the resistance to static and normal fatigue stresses. It is also made clear how the marked destruction observed in corrosion-fatigue does not proceed from a general "wastage" of area of the specimen, but from a particularly dangerous form of surface discontinuity, which is peculiarly adapted to promote fracture under alternating stresses by the process of a spreading crack, but there is no relation between the amount of local or total damage under stressless corrosion and corrosion-fatigue, nor would this be expected. The cause of this difference, however, is at once understood when consideration is given to the effect of the cyclic strains on the corrosion products, and particularly on the protective oxide film. Very thin stable films are generally flexible, whilst thicker and less resistant films break more easily under stress. The marked resistance to corrosion-fatigue of high chromium steels and the passifying influence of chromate inhibitors form excellent examples. That corrosion-fatigue strength depends much more on the nature and properties of the film formed than on the primary resistance of the metal to corrosion is demonstrated clearly by such metals as the stainless steels. These steels are not intrinsically passive.

Thus, we conclude that the mechanism of the failure of metals when exposed to the simultaneous actions of corrosive environment and alternating stresses can be reduced to an ordered sequence of chemical and physical events, which are explicable, even in the present admittedly incomplete state of knowledge of the subject, by the established facts of corrosion and of fatigue, thus affording sufficient justification for the use of the term "corrosion-fatigue of metals."

* In some cases in service failure by corrosion-fatigue can be ascribed to the junction of dissimilar metals. Such junctions are, however, rare in laboratory tests.

The Vickers Damper.

We have received from Vickers-Armstrongs, Ltd., Naval Construction Works, Barrow-in-Furness, particulars of the Vickers damper, constructed under Sandner patents, which, we are informed, has been successfully applied in several recent oil engine installations carried out for the British Admiralty and for which Vickers-Armstrongs, Ltd., have acquired the sole licence for marine oil engine installations in the British Empire. Unlike other dampers in which a loose fly-wheel is attached to a shaft by means of a loose coupling that enables the fly-wheel to slip at a more or less indeterminate point, thereby altering the natural frequency of the system and so avoiding dangerous critical speeds, the Vickers damper does not depend for its effect upon absorption of energy, but upon a change in the synchronous speed of the system whenever

Fig. 1—Damper and Component Parts

that system is subjected to excessive vibration. It consists, as our illustrations indicate, of a loose fly-wheel so arranged that any relative movement between the fly-wheel rim and the shaft to which it is attached causes oil to be discharged by a series of gear wheel pumps. The discharge of oil is resisted by a spring-loaded valve and prevents relative movement unless the system is subjected to an oscillating torque of a predetermined magnitude. As soon as such a torque is reached the pump valve lifts and frees the fly-wheel. Synchronism is at once destroyed, the oscillations die down and the valve reseats itself. This cycle is repeated as long as the engine is running at a critical speed.

The construction of the damper is capable of considerable variation, but Figs. 1 and 2 show a typical arrangement. It—see Fig. 2—consists of two main parts, one the central disc A keyed to the shaft and the other the rim B, which is geared to A by a number of small gear wheels C. The pins on which the wheels C rotate are fixed in the

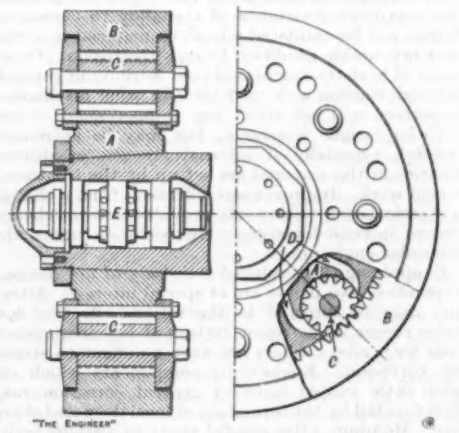


Fig. 2—Section through Damper

central disc and are housed in close-fitting cavities within it. When the wheels mesh with the internal teeth of the rim they form gear-wheel pumps, the passages D acting as suction and discharge conduits or *vice versâ* according to the rotation of the rim relative to the central disc. Suction and discharge valves are fitted in the casing E in the centre of the damper shaft and connect with the passages D. They are so arranged that relative motion between A and B in either direction of rotation is resisted by a spring-loaded discharge valve set to open at a predetermined pressure. Oil from the forced feed lubrication system of the engine or other convenient source of supply is led to the central cavity, generally by a hole through the shaft, so that the interior of the damper is always full of oil under a moderate pressure. As long as the pressure in the gear wheel pump system remains below that at which the discharge valves are set the whole damper revolves as one unit. When, however, owing to oscillations above a certain amplitude the pressure in these pumps rises, the discharge valves lift and the rim is freed from the central portion. As both the suction and discharge valves draw from and pump to the central cavity of the damper no great supply of oil is required for the operation of the damper. The only oil which passes through it is that resulting from leakage, and

the oil which passes through a small vent provided in order to maintain the damper free from air. When in action the relative motion between A and B is very small, so that the heating effect of the oil is practically negligible.

The arrangement and size of the damper depend upon the system in which it is to be applied. The total rotational mass added to that of the fly-wheel, if a damper is fitted, must, of course, be sufficient to confine the cyclic irregularity to the limit required. This total mass may, however, be adjusted if, in certain cases, it is desired to avoid a critical speed of any particular value. The rotational mass of the damper rim is so arranged that the increase in the synchronous speed when the rim is freed is outside the range of the original critical speed without entering into the range of a critical speed of another order.

Figs. 3, 4 and 5 show typical Geiger torsiograph vibration diagrams taken from an oil engine propelling plant. Fig. 3 shows a typical range of torsional vibrations from A to B with a critical speed at C. The amplitude of the oscillation

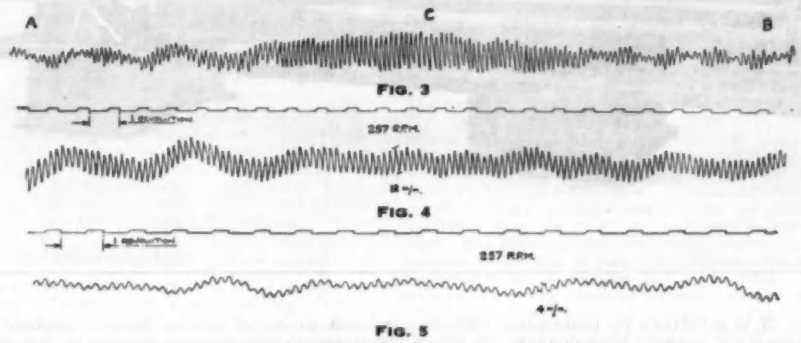


FIG. 3

FIG. 4

FIG. 5

TYPICAL GEIGER TORSIOGRAPH DIAGRAMS

and the stress on the shaft is indicated by the height of the crest to hollow on the waves. Fig. 4 is another Geiger diagram taken from a high-speed oil engine running at 275 r.p.m. with the damper purposely set out of action. Fig. 5 shows a similar diagram taken under the same speed conditions, with the damper in action and with, it may be noted, a greatly reduced shaft stress. Vickers-Armstrongs, Ltd., are prepared to design suitable dampers on receipt of particulars of the engine and shafting system and the critical speed calculations, or alternatively, in the case of orders to calculate without charge from the data supplied the critical speeds existing in the system and to advise the correct design of damper necessary to meet the conditions of operation.

A Portable Polyphase Meter Testing Set.

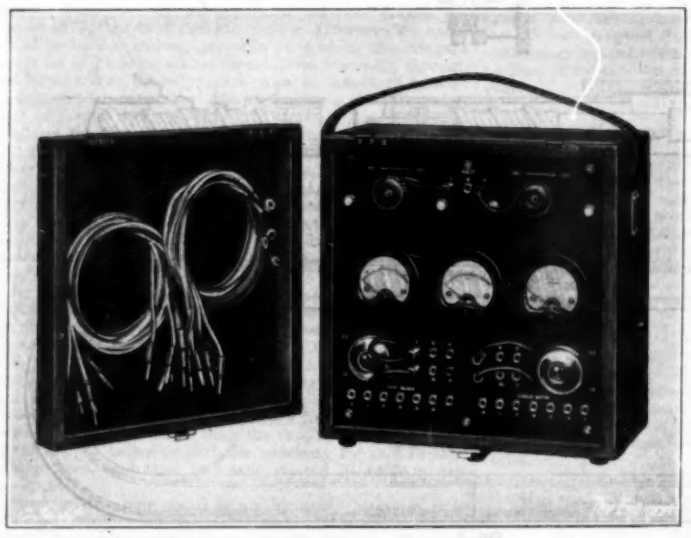
THE portable testing set shown in the accompanying illustration has been introduced by Chamberlain and Hookham, Ltd., of Birmingham, for the purpose of testing polyphase meters on site and provides the means whereby a three-phase load may be applied to a meter connected on the secondary side of current transformers and with or without potential transformers. Hitherto it has been common practice when carrying out tests on site to connect a check meter in series with the meter to be checked, and after a period of several days of operation to compare the readings of the two meters; but, generally speaking, the comparison only shows the average error over the period without giving indication of those at specified loads. Usually the load is not under the control of the testing engineer, and at certain loads and power factors considerable errors may exist and be undetected.

An alternative method is to remove the meter from the site to the test room or some other convenient place where testing facilities exist and to test over the whole range of measurement at various power factors, but the objections to this scheme are that when the meter is disturbed the error may be removed or modified or, conversely, the movement of the meter may introduce an error. In any case, the makers of this new apparatus explain, there is no guarantee that the conditions of working on site will be reproduced in the test room, and suspicion may be aroused in the mind of a consumer if a meter suspected of being inaccurate is removed from his premises for testing.

The apparatus under consideration has been designed to remove these objections and to enable a complete series of tests to be carried out on site at any desired load and over a power factor range sufficient to satisfy all practical requirements. It consists of a polished teak case with a strap handle and removable hinged lid, the dimensions when the case is closed being 13¼in. by 13¼in. by 8¼in. and the weight 32½ lb. A polished bakelite panel carries meters, switches, plug sockets, and the handles of the regulating resistances, whilst behind the panel the resistances and transformers are mounted.

For providing the power necessary for energising the current coils of the meters to be tested a three-phase supply is essential, and the total load when the apparatus is fully loaded is approximately 20 VA per phase. The current coils of the meters to be tested are fed from the load transformer, the red phase being connected to red sockets, the blue phase to blue sockets, and the check meter to other sockets. A regulating resistance in each phase enables the current to be varied between full load and one-twentieth load, and the current in each phase can be varied independently, so that if desired, unbalanced loads may be obtained. An ammeter with a full-scale reading of 1 ampère is inserted in each of the two current circuits and is fed from the secondaries of two small current transformers having tapped primaries giving ratios of 1/1 and 1/5 and controlled by two-way switches which ensure that the secondaries are never open-circuited and that there is therefore no risk of damage to the transformers. Connection between the meter current circuits and the load transformer is obtained by means of plugs inserted in sockets, and a diagram indicates the appropriate sockets for a range of power factors between zero lag and zero lead. The pressure coils of the check meter are connected in parallel with those of the meter or meter to be tested, and a voltmeter with three sockets enables the pressure between any two phases to be checked. A set of leads with sockets and terminals appropriately marked is provided for connection between the testing set and check meter, and also to the meter panel test block if one exists, but if this is not the case suitable connections may easily be arranged.

The testing set is said to have proved very convenient under working conditions, enabling as it does site tests to be made on kilowatt-hour and reactive meters throughout a sufficient range of power factors to allow calibration to be made at any desired load. The set can also be used in the test room or elsewhere for checking up the check meter against a standard indicating wattmeter and for various other purposes.



TESTING SET FOR POLYPHASE METERS

Oil-Electric Trains for India.

FOUR oil-electric motor-trains of a new type, made by Armstrong, Whitworth and Co., Ltd., have left Newcastle for shipment to India on the s.s. "Mundra," which sails from the Royal Albert Docks, London, on September 17th. The new trains, which were designed especially for H.H. the Gaekwar of Baroda, are intended for service on the 2ft. 6in. lines of the Baroda State Railways, and, it is said, will be the first oil-electric railcar tractors ever used on an Indian railway. Each of the railcar tractors, bodies for which are to be built in India, has been designed to haul three third-class coaches, with a total weight of 30 tons. The railcars themselves will accommodate first and third-class passengers, while one, or perhaps, two, will be fitted with mail compartments. The cars can be driven from either end. The prime mover in the railcar tractors is an Armstrong-Saurer engine, developing 80 B.H.P. at 1600 r.p.m., and 95 B.H.P. at 2000 r.p.m. It is direct-coupled to a D.C. generator, and the complete unit is mounted on a three-point suspension system within the bonnet at one end of the vehicle. The cars themselves are of the six-wheeled type, with a single driving axle at one end, and at the other a bogie of unusual but practical design. The single traction motor is wholly spring-borne, and is placed high above flood level. The axle is driven through a cardan shaft and worm gearing. The main particulars of each car are: Length over buffers, 26ft. 1½in.; maximum axle load, 6 tons; weight in working order 13·5 tons; maximum tractive effort, 3500 lb.; maximum speed, 30 m.p.h.

The "Enox" Pocket Saw.

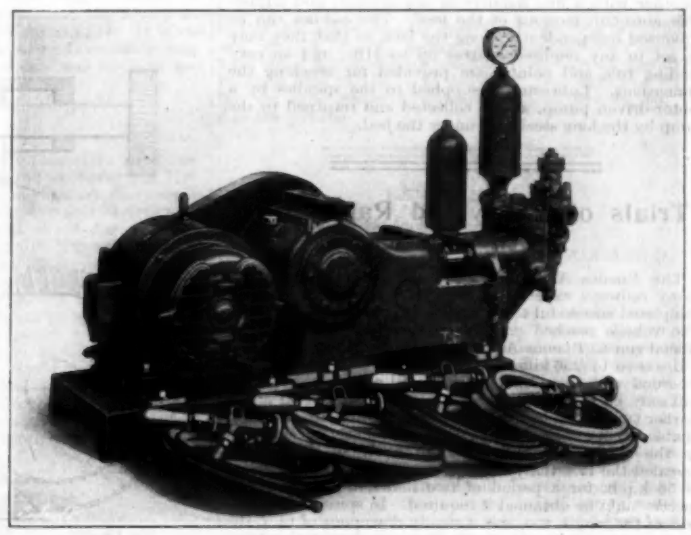
A NEW pocket saw, known as the "Enox," has just been put on the market by Fry's (London), Ltd., of King-street, London.

The tool has a highly polished nickel-plated handle and is fitted with three saws and one short-bladed knife. Each saw blade is manufactured from first-quality steel, suitably tempered for the particular work that it is required to do, and is about 4in. in length and of sufficient stiffness to cope with all metal or fibre cutting. The knife is regarded as particularly suitable for plumbers and other operators on lead, and for the cutting of belting. Special blades, varying in thickness and having unset teeth, can be supplied for slotting. A good feature of the "Enox" pocket saw is that there are no loose parts and so there is no necessity to remove a screw or a wing nut once the tool is fitted with the selected series of tools, except, of course, for the insertion of replacements. The handle completely encloses the saw blades, and the dimensions are approximately 5¼in. by 1¼in. by ⅝in. when closed.

Washing Cars by High-Pressure Water.

MOTOR-CAR washing by means of jets of water delivered at a high pressure is becoming very popular, and a new equipment for this purpose, made by B.E.N. Patents, Ltd., of 92, Tottenham Court-road, London, W.1, which we illustrate, appears to have merits. It comprises a pump capable of delivering water at a pressure of from 350 lb. to 375 lb. per square inch to two, three, four or six "guns," or washing jets.

The pump, which is enclosed and self-oiling, is of the horizontal three-throw, single-acting type, fitted with Firth's stainless steel plungers. The crank shaft is machined from a solid bar of special 40-ton tensile steel, heat-treated and ground, and is carried on two oversize ball bearings. The connecting-rods are of steel drop forgings, and the big end bearings of anti-friction metal. They are fitted with laminated shim adjustment. The crossheads work in long machined slides, and manganese bronze bushings are provided for carrying the crosshead pins. The crankcase and pump body are one piece castings of chromidium grey iron, the lower part of the crankcase forming the oil sump with means provided for adequately flooding all rotating and sliding parts, which are completely enclosed. Large stuffing-boxes with heavy manganese bronze fittings are provided on the pump body for each plunger, and oil-retaining glands are also provided on the forward end of the crankcase. Valves and renewable seats are of manganese bronze. An automatic pressure unloader and by-pass is provided which regulates and controls the working pressure under all conditions. When no washing guns are in use the controller maintains a set pressure, but by-passes surplus water into the pump



CAR-WASHING PUMP

DUPLEX BORING AND FACING MACHINE

suction under low pressure only, thus completely unloading the pump and relieving the motor of all but the friction load of the machine. The machine is driven by a motor of from 2 H.P. to 7½ H.P., according to the number of guns which it has to serve.

Horizontal Duplex Boring and Facing Machine.

THE motor driven horizontal duplex boring and facing machine illustrated by an engraving at the head of this page was recently made by Kitchen and Wade, Ltd., of Halifax, for the Egyptian State Railways. It is intended for machining locomotive side and connecting-rod bushes, which are bored and faced at one setting of the rod. For these operations expanding tools and self-acting facing heads are supplied.

The machine has two headstocks, each fitted with a deep jaw chuck, which has some angular motion operated by worm gear. That on the left is fixed, while the other can be moved along the bed to accommodate rods of varying lengths up to 12ft. 6in., while the height of centres above the bed is 1ft. 1in. The rods are supported in two steadies, which are equipped with three-way adjustment for nipping the rods after the initial setting has been made. Two independent saddles, each with its own motor drive and speeds and feeds to suit the different diameters of the rods are mounted on the bed. The driving heads are bolted to the top slides, which are made very long, with the object of ensuring alignment when boring. Six changes of speed and three rates of feed are available, together with a fine hand cross adjustment, and adjustable auto-trip motions of the feed. The saddles can be traversed independently along the bed, so that they may be set to any required centres up to 11ft., and an easy reading rule and pointer are provided for checking the dimensions. Lubricant is supplied to the spindles by a motor-driven pump, and is collected and returned to the sump by the long steel tray under the bed.

Trials of a Leyland Rail-Car in South America.

THE Buenos Aires and Pacific Railway, one amongst many railways experimenting with railcars, has recently completed successful trials with a Leyland-engined model. The vehicle reached and maintained high speeds on its official run to Buenos Aires from the workshops at Junin, a distance of 256 kiloms. An average of 61 k.p.h. was recorded with ease, though in actual service the vehicle will only be required to maintain an average of 50 k.p.h. Earlier types of railcar operated by the company had been unable to cope with the high winds frequently encountered on the tracks, but the Leyland, in an 80 k.p.h. gale, revealed the fact that, not only could it maintain a speed of 56 k.p.h. for a period of two hours, but that higher speeds could be obtained if required. In spite of the coldness of the winds, too, and a steady downpour of rain, the engine was easy to start at all times during the trial, although fears had been entertained that, having the extra large water capacity necessary for summer temperatures, it might prove a little obstinate during the cold periods.

The vehicle has been designed for branch line service where the number of passengers does not warrant the employment of an ordinary steam train. It is of the two-axle type, providing accommodation for thirty-three passengers, not including the driver. Two driving compartments are provided, the controls being duplicated and arranged so that only one set can be in operation at any given time. The driving unit is a Leyland six-cylinder engine, developing 90 B.H.P. at 1700 r.p.m. and rated at 38·4 H.P. The four-speed gear-box forms a combined unit with the engine, the drive from the gear-box being taken by means of an intermediate cardan shaft to a reversing gear-box and thence to the worm-driven rear axle. The engine, intermediate shaft, and both gear-boxes are carried in a sub-frame mounted on rubber pads within the main frame, an arrangement which permits the engine easily to be withdrawn for maintenance purposes. The springs are of the long-span laminated type, the wheels are 3ft. diameter steel discs, and the brakes are vacuum operated, the power being supplied by the engine.

A New Mechanical Power Transmission Cable.

WE have recently had brought to our notice a new form of mechanical power transmission cable such as is used for the flexible connection in distant control devices. The cable is the invention of Mr. W. E. Barber and Mr. H. A. Watts, both of the Royal Aircraft Establishment, Farnborough, and is being placed on the market by the Duette Manufacturing Company, Ltd., 21, Northumberland-avenue, London, W.C.2. The cable has, we understand, already received application in aeronautical work, but it is claimed to have a very wide field of use, particularly in the naval and mercantile marine, for motor cars, and for various purposes in connection with the light and heavy electrical industries.

The core of the cable, as indicated in Fig. 1, consists of an ordinary flexible steel cable, of, it may be, ¼in. diameter. On top of the core a layer of wire is wound with a fine pitch, the winding being of opposite hand to the lay of the wires composing the core. This first layer of wire winding may be composed of two or more wires laid side by side. Over it a second layer of wire is wound, the direction of winding being opposed to that in the first layer. This second or outside layer is characterised by the fact that of the wires composing it one is of large diameter, while the others—three, it may be, in number—are small. The result is that the large diameter wire stands up round the completed cable like a screw thread.

The completed cable retains practically all the flexibility of the core, for the spiral layers do not appreciably affect the freedom with which the cable may be bent transversely. The spiral layers have the important effect of permitting the completed cable to transmit not only push and pull, but also rotational motion. The ability of the cable to transmit rotational motion without uncoiling is to be attributed to the opposed winding of the two layers and the core. The cable can be enclosed in an outer tube, which may be bent to follow any required run. So enclosed it is capable with suitable arrangements at its ends of transmitting at will either push or pull or rotational motion.

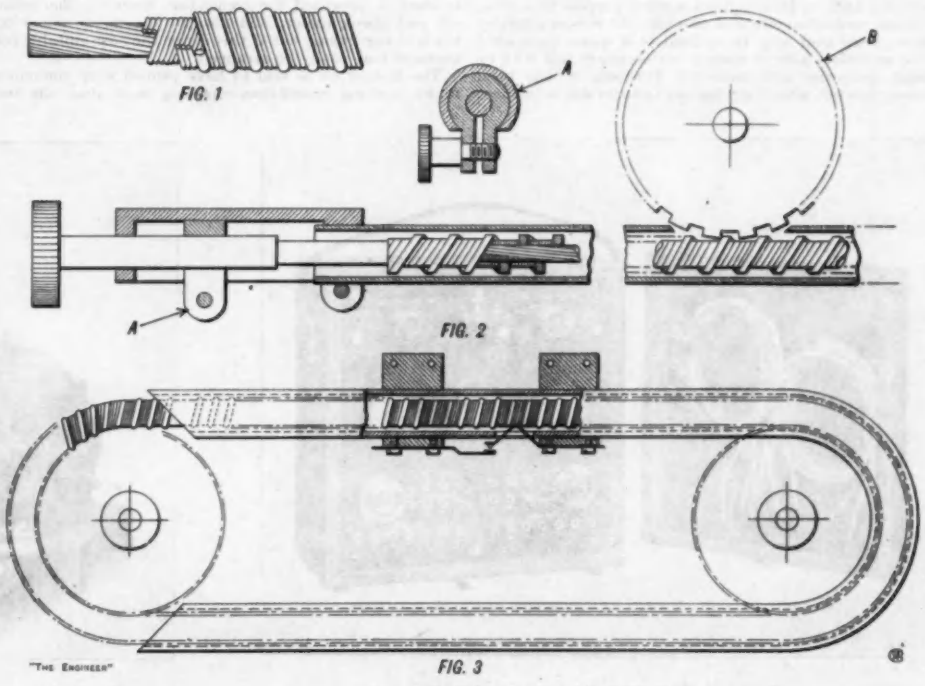


FIG. 1

FIG. 2

FIG. 3

The upstanding wire of the outer layer may be regarded as constituting either a flexible screw thread or a flexible rack. In Fig. 2 we illustrate an application of the cable illustrating both uses. If the clamp A is fixed the cable is prevented from rotating. Pressure or a pull on the button at its end will then cause the upstanding wire to act as the teeth of a rack and to turn the wheel B on its axis. Alternatively, the clamp A may be released and the wheel B be rotated worm and worm-wheel-wise by rotation of the button.

An important feature of the invention is the fact that the control of the movement of the cable is not confined to a position at its end. At any point the surrounding tube may be slotted and a wheel such as B inserted to engage with the upstanding wire. Rotation of this wheel will then impart longitudinal motion to the cable. Similarly, provision can readily be made to insert at any point in the length of the surrounding tube a clamping device which will permit rotational movement to be imparted to the cable.

As an illustration of the many uses to which the cable may be put we illustrate in Fig. 3 an arrangement of it whereby an electrical contact may be made and broken at successively long and short intervals by the simple turning of a handle. It will be observed that the cable is arranged as an endless band which passes over toothed driving wheels. The electrical contact is made and broken by the upstanding wires, intermediate turns of which are filed flush to give the prolonged breaks. The device might be used in this way for the automatic transmission of S O S messages.

A RADIO Exhibition is to be held in the City Hall, Manchester, from September 28th to October 8th.

Canadian Engineering News.

Canadian Chemical Industries.

THE use of chemicals in Canadian industries is constantly expanding, and is being paralleled by a rapid growth in their manufacture. The last few years have been marked by greater activity in the chemical industry than at any period since the war. For the year 1930 the value of chemical manufactures produced was 119,969,637 dollars, while the value of production of other industries using chemical processes was 631,340,933 dollars. The year 1930 did not record the maximum of production in these industries, but, in the four years since 1926, there was an increase of 10 per cent. in the output of chemicals and of 3 per cent. in the production of other industries using chemical processes.

Placer Mining.

An extensive placer mining operation is to be started at once on the Bridge River, in British Columbia, where Lower Bridge River Placers, Ltd., is installing an 8in. monitor for hydraulic gold mining. The company, which has its headquarters in Vancouver, has extensive placer leases, including both bench and river claims, along Bridge River. Hydraulic mining is to start on the benches, and it is estimated that there are 6,500,000 cubic yards of gold-bearing material on the north benches, and 2,500,000 cubic yards on the south benches. The initial operations will be carried out on the north benches. The property is about 12 miles from the mouth of Bridge River and 120 miles north-east of Vancouver.

Oil Burner Testing Facilities.

In response to insistent pressure by the oil burner manufacturers of Canada, the National Research Council, with the approval of the Privy Council Committee for Scientific and Industrial Research, has undertaken to provide in the National Research Laboratories at Ottawa, facilities for the testing of domestic oil burners for fire hazard. The equipment installed includes a battery of hot water and steam boilers of different capacities. Each boiler is fitted with individual flue and heat-dissipating equipment enabling the boiler and burner to be operated under normal conditions. The oil supply system is arranged to correspond with that usually found in house installations. Specially devised equipment is being provided for operating the controls and safety devices of the burners in order to detect weak features or unsatisfactory behaviour. Particular attention will be devoted to the examination of the electrical elements. Provision is being made for the accurate determination of the characteristics of the oil burned and the operating conditions, such as draught and temperatures. It is expected that the oil burner testing equipment will be the first unit in fire-testing laboratories which will eventually be equipped for testing the whole range of fire-resisting and fire-fighting materials and equipment. Canada at the present time lacks facilities for this work.

The New Welland Ship Canal.

When Lord Bessborough, Governor-General of Canada, on the afternoon of August 6th, pressed a button and officially opened the new Welland Ship Canal, he wrote *finis* to a page of Canadian history marked by high achievement. At a cost of 130,000,000 dollars Canada has ended a task started nineteen years ago, and finds herself in possession of a canal ranking with the five other great canals of the world.

In 1818, William Hamilton Merritt, whose name had become renowned by his youthful exploits during the war of 1812, first took definite steps to ascertain if a canal could be built. During patrol in 1814 along the Niagara River he had conceived his idea. After tramping through the bush, a level his only instrument, he definitely decided to launch his adventure. His story is one of vicissitudes, lack of funds, tedious travels to Quebec, New York and England for money. In 1824 his company was formed, and finally, in 1829, two ships, one Canadian, the other American, sailed from Lake Ontario to Lake Erie. There were twenty-six locks in his first canal, and it utilised part of the Niagara River for its route. In 1833 it was fully completed, with forty locks from Port Dalhousie to Port Colborne. It was in those days a tremendous undertaking. The locks were 110ft. long with a draught of nearly 8ft.

In 1841 the Legislature of Upper Canada—to which Merritt had attained election merely to seek advancement for his dream and from which he resigned when he attained it—took over the canal. By 1850 it had been enlarged and reopened for traffic, with stone locks replacing the pine timber, and enlarged to 150ft. long and 9ft. in depth, and in 1882 the third Welland Canal was completed—literally an enlargement of Merritt's first tiny cut—with locks 270ft. long. Since then the rapidly enlarging ships of the Upper Lakes caused the necessity for still further enlargement, and that task was started in 1913 by the Dominion.

Much of the new canal is wholly new; some of it is enlarged sections of the old canal. It has occasioned wholly new engineering feats for this reason. Not for one minute has traffic in the old canal been interrupted, although the new canal crosses the old waterway seven times, and it stands pre-eminently to-day as the world's finest and greatest example of high lift navigation, traversing a drop in 25 miles of 327ft. The average lock lift is 46½ft., and the length of each is 860ft. to provide for ever-increasing ship dimensions of the future. Its guard lock is the longest and largest in the world, 1380ft. between gates, and it is traversed by twenty movable bridges in its 25 miles of length.

Pipe Plant.

The new plant of Pressure Pipe Company of Canada, Ltd., manufacturers of high-pressure pipe, was formally opened at North Vancouver, at the end of July. The company's product is known as Bonna pipe, and is of the type that is being laid in the pressure tunnel under First Narrows, Burrard Inlet, for the Greater Vancouver Water District.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Automobile Engineering Prospects.

THAT the forthcoming season holds much better prospects than last year for the automobile industry is the generally accepted view of Midland motor car manufacturers. The trade is looking forward to a record year, and some firms are increasing the size of their works to deal with the volume of business which the orders recently received suggest will eventually be forthcoming. One factory which is now practically completed has been built in less than ten weeks in Birmingham. It is a factory that has grown up under Sir William Morris's direction. About three months ago, when the Wolseley Company decided on its 1933 programme and fixed the date for production, the works manager said it could not cope with the output demands, as the shops were still busy on the 1932 cars. Sir William Morris was referred to, and promptly gave instructions that a new factory should be erected. That was nine weeks ago. Since then builders, working day and night, have erected a steel hall covering an area of 110,000 square feet and utilising 600 tons of British steel. Machinery is being installed, and any day now operations may begin. The Austin Motor Company states that it has taken more orders during the first three days following the announcement of the new season models than it took in the whole of the corresponding week last year. The Birmingham Information Bureau reports that overtime is the rule in many Birmingham factories manufacturing motor accessories and components. A firm of sparking plug and electrical accessory makers states that the demand, which is greater than last year, is necessitating the rearrangement of the assembly benches and the working of overtime. "We are working day and night, Saturdays and Sundays," stated a representative of another Birmingham firm, which claims to be the largest motor car bumper manufacturer in Europe. The firm has recently installed an automatic polishing plant, which, outside America, is the most up to date in the world. Representatives of other Birmingham firms speak cheerfully of the prospects for the 1933 season. A large factory is nearing completion in Birmingham where motor tire valves, which are not at present manufactured in this country, are to be produced by a Swiss firm.

Trade Returns.

Midland industrialists have carefully scanned the Board of Trade returns for the month of August, and though they are disappointed with the value of exports, they welcome the falling away in imports, especially of goods manufactured in this area. It is noted that imports of manufactured goods last month were £7,000,000 less in value than in August last year, and that imports of iron and steel and manufactures thereof dropped from £1,357,894 to £498,318, and machinery from £1,051,329 to £701,185. The total quantity of iron and steel imported during the month was 105,072 tons, compared with 201,920 tons in the corresponding month last year. For the year to date the quantity imported was 1,191,305 tons, compared with 1,709,714 tons in the preceding year. The fact that imports in the vehicles group increased from £245,392 to £336,415 is commented upon. The net decrease of £585,000 in British exports last month, as compared with a year ago, is mainly accounted for under the heading of ships and locomotives. The value under the former heading last month was only £164,096, as against £827,685 in August last year, and the figures for locomotives dropped from £190,647 to £13,254. It is the vehicles group which prevents a more favourable comparison of exports for the year to date and those of last year.

Foreign Hollowware.

Midland manufacturers are pleased to learn that the Board of Trade Standing Committee under the Merchandise Marks Act supports the application of the galvanised hollowware section of the Wrought Hollowware Trade Employers' Association and others for an order for the marking of the place of origin on imported wrought hollowware of iron and steel used for domestic or agricultural purposes, and recommends the making of an order. The Committee, in its report, pointed out that the application was unopposed, that the retailers were of opinion that an Importation Order was necessary for their protection, and that an Importation Order is in operation with regard to enamelled hollowware. Staffordshire and East Worcestershire manufacturers have long complained of the difficulty of selling their products against unmarked foreign goods, and they believe increased business will come to them as a result of the enforcement of this Marking Order.

New Type of Vessel for Midland Canal.

In order to augment its fleet the Severn and Canal Carrying Company, Ltd., Birmingham, has placed a contract for an entirely new type of motor barge for working in the general cargo trade between the Bristol Channel ports and Worcester and Stourport, on the river Severn. The barge will be powered with a three-cylinder engine, and is designed to carry 125 tons of cargo, and will be able to reach Stourport with this load, which is the nearest point to the Birmingham district to which a vessel of this size can navigate.

Walsall Manufacturing Toys.

Matthew Harvey and Co., Ltd., of Walsall, have started to manufacture a cast iron "top" of the "Yo yo" type, named the "Hylo," and by so doing have introduced a new class of manufacture to the district. Although production commenced only a month ago, the output has reached 20,000 a day. Up to the present only the home market is being supplied, but the firm has inquiries from abroad which it hopes will materialise.

Steel.

The advance in values of Continental steels increases the chances of better business for district steel works. At the moment consumers have stocks of material sufficient for immediate requirements, but when they need fresh supplies they are almost sure to give more attention to the products of native steelmasters. At date there is no marked evidence of advance in the rate of steel consumption. General engineering is a little brighter here and there, but structural engineering makes little advance. The rolling stock industry on the whole is quiet, while boilermakers remain short of orders. The tube trade is moderately employed, and there are signs of some revival in demand for nuts and bolts and screws. The Staffordshire and Worcestersnire hollowware trades are moderately busy. There is no change in values of finished steel, which are upheld at the Association level. Angles are £8 7s. 6d., tees, £9 7s. 6d., joists £8 15s., ship, bridge and tank plates, £8 17s. 6d., all less their respective rebates. Boiler plates sell at £8 7s. 6d. to £8 10s. Staffordshire re-rollers have made no change in their quotation as yet, though it is probable they may do so if the upward movement in Continental billets continues. Native small steel bars re-rolled from Belgian billets are quoted £6 7s. 6d., while all-British bars cost £7 upwards. British billets range from £4 17s. 6d. to £5 7s. 6d. The market for heavy steel scrap is depressed and prices are on a very unremunerative level.

Sheet Prices.

Galvanised sheet prices have advanced a further half-crown per ton as a result of the dearer cost of spelter. Selling values are now based on £9 7s. 6d. per ton f.o.b. for galvanised corrugated sheets of 24 gauge. District mills continue to operate below capacity and they would welcome additional support from oversees buyers. The home trade keeps up fairly well, but oversees markets are at date frankly disappointing. There has been an improvement in buying of black sheets for the motor car industry. There are adequate supplies of all classes of sheets available.

Raw Iron.

The current business in the raw iron industry in the Midlands grows slowly stronger. There is little change in the situation noticeable on the week, but looking back a little further definite growth in the volume of demand over the period is discernible. Derbyshire and Northamptonshire blast-furnacemen have stocks of foundry material available to meet any excess requirements of users, while current output is, at least, equivalent to consumption. The autumn demand from the light castings foundries is developing slowly and engineering foundries are absorbing slightly more material. Forge grades of pig are in poor request, the consuming works in the Black Country being far from actively engaged. Smelters still have the advantage of relatively cheap coke, and in many instances they have entered into commitments to the end of the year. Selling prices of pig iron are unchanged at £3 2s. 6d. for Northamptonshire No. 3 foundry, and £2 17s. 6d. for forge, £3 6s. for Derbyshire and North Staffordshire No. 3 foundry, and £3 1s. for forge, all per ton delivered to Black Country stations.

Staffordshire Bar Iron.

The situation in the Staffordshire finished iron industry is materially unchanged, the week having failed to produce any increased trade movement. Operations at the works are on a hand-to-mouth basis, and order books are very thin. Demand is similarly poor in all departments, though makers of marked bars fare rather better than those engaged upon the production of medium and common brands. Selling prices are unaltered, marked bars being £12 at makers' works, Crown bars £9 upwards, common bars £7 15s. to £8 delivered. Wrought iron strip for the tube industry remains weak at £10 7s. 6d. to £10 10s. per ton.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

Credits for Export Trade.

So far, beyond the bare announcement that the Government, through the Export Credits Guarantee Department, has decided to extend the period covered by credit facilities in connection with export business to Russia from twelve months to eighteen months, thus reverting to the practice in operation up to a few months ago, Lancashire engineers have no exact knowledge as to the extent to which the facilities will be granted. They are hopeful, however, that the guarantees will be forthcoming on a sufficiently broad basis to afford them real help in the quest for much-needed export business. As has been emphasised in this column during recent weeks, many Lancashire engineering firms which have been working on contracts for Russia have been seriously harmed by the previous decision to curtail the period over which Russian credits would be operative. Within the last year or so work in Lancashire engineering shops on orders for Russia has been on an extensive scale, both actually and relatively, but the completion of much of this during recent months and the failure to secure fresh credit terms on the same basis as before, thus preventing the booking of further contracts which were available, have had a serious adverse effect on operations in many establishments in the district and dismissal of employees has been inevitable.

A Varied Field.

In the campaign for the reversion to the *status quo* which Lancashire engineering concerns have been waging, most, perhaps, has been heard of the position of machine tool makers, not only in Lancashire, but also in some of the West Yorkshire districts. Firms in this branch are hopeful that the Government decision has not come too

late to have a markedly beneficial effect, notwithstanding that important business has undoubtedly been missed during the past few months, in consequence of the inability to take up contracts that were available because of the inadequate credit facilities. Other sections of Lancashire engineering stand to benefit also. Textile machinery makers may derive some advantage, although in this case the prospects are perhaps more problematical, for the past two years or so have witnessed a pronounced falling off in the Russian purchases of textile machinery from this country. Electrical engineering firms and manufacturers of engineering products of a speciality type are, however, among the Lancashire concerns which are not without hope that the alteration in the credits arrangements will ultimately operate to their advantage.

Electrical Manufacturers' Profits.

Although the net profits for the twelve months ending June 30th last are nearly £6000 below those of the previous year and £14,000 less than in 1929–30, the results of the year's working of Ferranti, Ltd., electrical engineers, of Hollinwood, near Manchester, must be regarded as very satisfactory in view of the prevailing conditions. The profits for the past year amount to £54,904, compared with £60,689 in 1930–31, and £68,749 in 1929–30, and the available balance, including £35,980 brought in from the previous year, is £90,884. The ordinary shareholders receive a dividend of 6 per cent., as in each of the two previous years, and the sum of £41,545 is carried forward to the next accounts.

Non-ferrous Metals.

The persistent firmness of the non-ferrous metals markets during recent weeks has given way to a spell of weakness which developed spectacularly on Tuesday of this week. Prices in all sections have experienced severe falls, but the decline in copper was the heaviest relatively. At the moment it is not easy to diagnose causes apart from selling pressure arising almost entirely from profit-taking operations. At one time since last report values of standard brands of copper reached a slightly higher level than those quoted here a week ago, buying interest of a fairly substantial character still being in evidence. This, however, largely subsided, and gave way to the selling wave already mentioned. Prices of standard brands current at the moment of writing are fully £6 per ton lower on balance, and the whole of the advance of the three previous weeks is thereby wiped out. With regard to tin, the demand on occasion attained important dimensions, and quotations were firm. When the reaction set in it developed apace, the net loss on the week being only slightly less than £10 per ton. Conditions in the lead market have been very similar to those obtaining in respect of copper and tin, the week's decline being no less than about £1 15s. per ton, with spelter quoted lower to the extent of £1 5s. per ton.

Iron and Steel.

Conditions on the iron and steel markets here have been uneventful. Although the prospects of an early end to the Lancashire cotton dispute are, at the moment, regarded more hopefully, the fact that the stoppage continues in operation not only exercises a depressing influence, but is also directly affecting business. In the case of foundry iron, fresh buying interest this week has remained at a low level and few new orders of importance have been booked. For much of the poorness of the pig iron trade in this area, makers are blaming the scrap position, heavy supplies of good quality material being available at prices which cannot but prove tempting to many foundries. Apart from the reduction last week-end in Scottish pig iron, quotations are more or less where they were a week ago, Derbyshire, Staffordshire, and Cleveland brands being quoted for delivery equal to Manchester at 67s. per ton, Northamptonshire at 65s. 6d., Derbyshire forge at 62s., Scottish foundry at about 82s. 6d., and West Coast hematite at 81s. Business in finished iron is of a retail character, but at £9 15s. per ton for Lancashire Crown bars, and £10 5s. for best bars prices keep steady. In the steel market current buying of almost all descriptions of material, including special alloy steels, is very moderate indeed, and inquiry for forgings also is quiet. Re-rolled bars are quoted at from £6 15s. to £7 per ton, acid and basic boiler plates at about £8 10s., joists at £8 15s., sections at £8 7s. 6d., general plates at £8 17s. 6d., and large diameter bars at £9 7s. 6d. The demand for imported materials is quiet, but a feature has been the sharp rise latterly in quotations for Continental products for delivery to Manchester. Current rates, including duty, are at about £6 15s. per ton for Thomas plates, £7 10s. for Siemens plates, £5 17s. 6d. for bars and angles, and £4 10s. for billets and sheet bars, including delivery to works in the Manchester district.

BARROW-IN-FURNESS.

Hematites.

Business in West Coast hematite pig iron is very quiet. Locally sales are taking place from stocks, on account of steel makers, but on Continental account there is next to nothing doing, and shipments are meagre.

Iron Ore.

For hematite iron ore there is only a small demand on the part of local smelters, and outside trade is limited. Very little Spanish ore has come into Barrow for quite a while.

Steel.

There is a fair amount of activity in the steel trade, the chief output being that of steel rails. Hoops, spring steel, and steel strips are also being rolled. For rails there is only a light demand, both on home and overseas account. Hoops, &c., are in steady request. Steel castings are a fair trade.

SHEFFIELD.

(From our own Correspondent.)

Steel Trade Optimism.

BASED on increased activity in the market for raw materials and a slight improvement in actual trade, there is an optimistic feeling in the local steel industry that the clouds of depression are beginning to lift. Of course, the raw materials markets always provide a genuine indication of the state of trade, and the purchases are a sign of coming activity on the part of the manufacturers. Indeed, it is a fact that there has been an increase in the number of orders received by Sheffield steel firms, and although this tendency is expected after a holiday period, there are hopes that the improvement will prove lasting. Inquiries are fairly numerous, and there are signs that in many quarters stocks are in need of replenishment, whilst there is more inclination to discuss forward contracts. The dispute in the cotton industry is meaning some loss of work for Sheffield, but there is a prospect of more work being obtained as a result of the Ottawa agreements.

Local Steel Production.

Latest returns in regard to production of steel ingots and castings show that in the Sheffield area the output was 61,700 tons (including 18,100 tons acid and 38,200 tons basic) during the month of July. This total may be compared with 68,100 tons in the previous month and 70,900 tons in July of last year. Lincolnshire production in the same month was 42,900 tons, compared with 42,000 tons in June and 36,500 tons in July, 1931. Lincolnshire also produced in July 43,300 tons of pig iron, compared with 42,600 tons in June and 35,300 tons in July last year.

Special and Stainless Steels.

There is a better demand for special steels and light steel specialities. For stainless steel products there is also a good call and the production of small stainless steel castings is increasing. It is pointed out that not very long ago difficulties were experienced in securing on stainless steel castings the necessary perfectly smooth, polished surface, free from irregularities and pitting. But those difficulties have been largely overcome by the adoption of special moulding methods and materials, so that now castings are being produced which in their final finish meet the requirements of the most exacting users. Among the many stainless steel objects which are being made in the foundries at the present time are road studs, brackets, door plates, hangers, display letters, and meat hooks. There is an ever-increasing field for such castings.

Huge Stainless Plate.

At the Sheffield works of Brown Bayley's Steel Works, Ltd., there has just been completed the production of a stainless steel plate 32ft. long, 6ft. wide, and $\frac{1}{8}$in. thick. This plate is believed to be the largest of this width and thickness yet produced in this country. It is to be used in the manufacture of chemical plant.

Tool Trade Position.

Some manufacturers of twist drills are actively employed and large quantities of hack-saws also are being produced. But the saw trade generally is "patchy," and the same description may be applied to files. The position in regard to Ireland, which has long been one of Sheffield's best customers for tools, particularly those used in agriculture, is specially interesting, in view of the imposition of a tariff on such products by the Free State Government. It is understood that supplies of Sheffield-made scythes, sickles, hooks, and some other tools ordered in readiness for the present harvest were delivered just in time to escape the tax, which is 5s. per dozen on scythes. Some satisfaction may be obtained, in viewing the future, from the fact that very few farm tools and no cutlery can be obtained by Free State users from domestic sources, and practically all have to be imported.

Steel Firms Merged.

It is announced officially that the firm of Eaton and Booth, tilters and forgers, Owlerton Bridge Steel Works, Sheffield, has acquired the business and premises of the firm of Swift Brothers, rollers, of Owlerton. Both these firms are fairly old established and well known. Their premises are in close proximity, and their activities will be continued jointly under Mr. J. H. Trickett, proprietor of Eaton and Booth.

New Manufactures.

Considerable enterprise is being displayed by the Laycock Engineering Company, of Millhouses, Sheffield, in developing new manufactures. Some time ago the company began to make power washers for garage equipment, these being notable on account of their engineering efficiency, compactness, and smart appearance. One has just been supplied for use in Jerusalem, and many others are in use in large transport establishments in this country. Laycocks have also just added to their manufactures a special type of pulley block, which is a favourite in the market. These are being made under an arrangement, the marketing not being undertaken by the firm.

Lighter Trades Activity.

An order for 10,000,000 safety razor blades has just been booked by the Sheffield firm of George H. Lawrence, Ltd., which booked two orders of similar magnitude within the last twelve months, one in November last and the other in April. This firm is working at full pressure, and has found it necessary to undertake further extensions of works previously enlarged. A weekly output of 2,000,000 blades is aimed at, and it is stated that production costs have been brought down to those of Continental manufacturers. There has been some slight improvement in ordinary lines of cutlery and the scissors trade is greater, helped by new duties.

The Salerni Process.

Several Sheffield firms are tendering for the manufacture of the first plant to be used in connection with the Salerni coal-refining process. Sheffield has a special interest in this plant, as the low-temperature carbonisation process invented by Commendatore Salerni was first brought to English public notice by Professor R. V. Wheeler, of Sheffield University, at a conference of scientists in America. Lady Houston has agreed to find the necessary finance to prove the process commercially, and the rights of the process have been acquired outright for the United Kingdom by British Coal-Refining Processes, Ltd. Much of the testing and experimental work was done locally, and it has been decided now to complete the final stage of development, which calls for the erection of a full-sized retort working under commercial conditions. It is this plant, which, it is hoped, may be made locally.

Largest Trunk Cable.

Workmen of the firm of British Insulated Cables, Ltd., Prescot, Lancashire, are engaged in the Sheffield district at the present time in laying a trunk telephone cable, which is the largest ever put down in this country. It contains 542 pairs of wires, and is being laid between Leeds and Derby, a distance of 75 miles. Much detailed testing work has to be carried out as each length of cable is laid down and connected. Actually, each of the 542 pairs of wires has five distinct characteristics, which have to be measured and tested, and each two pairs have about seven characteristics which have to be balanced. The work is expected to last another three months, ending at Derby, and the final cable, more than adequate for present telephone work, will provide for the expansion of telephone services during many years to come.

NORTH OF ENGLAND.

(From our own Correspondent.)

Cleveland Iron Trade.

THE position in the Cleveland iron trade continues to improve. Deliveries to home consumers are increasing, and shipments to overseas firms are expanding a little, notwithstanding barriers to business with buyers abroad. Outlook is brighter than for a considerable time, and manufacturers hope soon to restart some of the plant that has been inactive for a lengthy period. Stocks of pig iron at makers' works are a good deal heavier than is desirable, but ironmasters incline to the belief that requirements in the near future will necessitate substantial withdrawals. Little enlargement of demand is needed to change materially for the better the unsatisfactory statistical position. A substantial proportion of the output continues to go into use at producers' own consuming departments. Merchants, consequent upon terms of contract with makers, are not in a position to do much home business in Cleveland pig iron, but are under no restriction as to the disposal of hematite iron. Second-hands report a few further small sales to the Continent of both Cleveland and hematite iron. Ironmasters still offer Cleveland iron at specially low prices to Scotland, where cheap Indian and other irons continue to be used, but for the home trade continue to adhere firmly to the fixed figures. No. 1 Cleveland foundry iron is 61s., No. 3 G.M.B. 58s. 6d., No. 4 foundry 57s. 6d., and No. 4 forge 57s.

Hematite Pig Iron.

Increased production of East Coast hematite pig iron by the restarting of the blast-furnaces at the Ayresome Ironworks, Middlesbrough, seems unlikely to appreciably weaken prices. Gradual growth of local and other home consumption and prospects of further sales to the Continent encourage hope that early requirements will at least absorb output. Merchants possess fairly large parcels of hematite, but while they are understood to have shaded rates asked by makers, they are not disposed to cut prices to any great extent. Mixed numbers are generally quoted at 60s., with No. 1 quality at 60s. 6d.

Ironmaking Materials.

The foreign ore trade is without new feature. Consumers have no need to enter the market, while sellers are not seeking orders at the low and unremunerative rates obtainable. The nominal price of best Rubio is 14s. 6d. c.i.f. Tees. Coke is in better demand. Good medium blast-furnace kinds are 14s. 6d. delivered at the works.

Manufactured Iron and Steel.

Some improvement is noted in the manufactured iron and steel trade, but orders for nearly all descriptions are still urgently needed. Quotations are firmly maintained.

The Coal Trade.

There are certain faint signs of returning trade on the Northern coal market. Most descriptions of coal are in better demand. There is not much foundation on which to build optimistic comment, but the feeling is just a little more hopeful. The gradual return to service of vessels which have been laid up will help the bunkering trade, and most of the ships starting from North-East Coast ports are taking cargoes, so that it may be that at last the turning point in the long depression has been reached. A great deal is not to be expected, however, so long as the trade barriers continue in countries which used to be the best customers for British coal. At the moment it must be confessed there is not much prospect of modification. Most of the Northumberland collieries are likely to work regularly over the next few weeks, though a certain number will not be able to avoid lost days. The output in its restricted volume is fully equal to meeting market requirements, and the potential production to-day, with the improved machinery, is enormous. The steam coal position for the remainder of this month

tends towards steadier conditions. Collieries producing favourite grades are comfortably booked, with an appreciable improvement in prospects. Northumberlands are steady, and sellers are not forcing the market, large being still indicated at 13s. 6d., with small rather firmer at 8s. 6d. Prime Wear are also steady, with large quoted at 15s. to 15s. 1½d., and small firm at 11s. to 11s. 1½d. Tyne prime are quietly steady at 12s. 9d., with small in good demand at 9s. In Durham County, for some classes of coal, there is only a very small inquiry, the more specialised brands alone being in regular request. The gas coal demand for early shipment remains very moderate, and all descriptions are offered freely. The early winter demand, so far, shows no sign of development, though exporters are becoming reserved for forward bookings. Prices, although unchanged, tend steadier. Best Durham gas qualities are 14s. 6d., and prime Wear 15s. Coking unscreened and small are irregular at 12s. 6d. to 13s. 3d. Bunker coals meet a better demand, and prices are steady at 13s. 6d. to 13s. 9d. for favourite classes, with good seconds at 13s. A bright tone is evident throughout the coke trade, with substantial bookings for prompt and over the winter months, and inquiries for additional supplies coming forward freely. Gas coke is now difficult to obtain and firmly quoted at 17s. 6d. Patent oven coke is steady, and the undertone is improving, not much being obtainable below 14s. 6d. now, and superior makes are fully 16s.

SCOTLAND.

(From our own Correspondent.)

Quiet Markets.

On the whole business in the steel, iron and coal trades continues on quiet lines. Bookings and inquiries on home account do not yet show definite signs of expansion. The export inquiry is, if anything, a little more encouraging, though actual business still remains on a comparatively small basis.

Steel and Iron.

Heavy steelmakers continue to suffer from the lack of buying power of their customers, especially shipbuilders and structural engineers. Specifications for plates and sections are few and far between, and outputs naturally are curtailed. Steel sheets are more promising, the export inquiry for the lighter varieties being well maintained. India, Mexico and China are in the market and inquiries are also to hand from South America.

Galvanised Sheets.

The demand for galvanised sheets is somewhat irregular. Steel tubes are busier owing in a measure to the postponement of the operation of the increased Australian tariffs until December 1st. In the bar iron and the re-rolled steel bars departments the outlook is still uncertain, business being irregular and inquiries of a light nature. Re-rolled steel bars are quoted £6 10s. home and £6 5s. per ton export.

Pig Iron.

During the past week a cargo of 2200 tons of pig iron arrived in this district from Calcutta. Home prices have been reduced, but so far there has not been any sign of increasing demands. Hematite is now quoted 67s. 6d. per ton delivered steel works, and foundry No. 1 70s., with foundry No. 3 67s. 6d. per ton f.o.t. makers' works.

Scrap.

Holders of scrap find material difficult to move and prices are a shade easier, with heavy steel quoted 33s. 6d., and cast iron machinery 42s. 6d. per ton.

Coal.

For several reasons the supply of round fuel, despite severe curtailment, is still in excess of requirements. Home demands are below normal, throwing extra supplies on the export market at a time when overseas demands are at a low ebb. West of Scotland collieries, especially in Ayrshire, are affected by the almost entire cessation of exports to Ireland, while the Lothians and Fifeshire areas are up against keen Continental competition and the restriction of imports into Continental countries. Practically all large fuels, with the exception of Fifeshire first-class steams, are in plentiful supply for immediate shipment, and prices as a rule can be arranged. Washed nuts, especially trebles and doubles, are the firm spot in the market. Aggregate shipments amounted to 231,534 tons, against 223,245 tons in the preceding week, and 248,793 tons in the same week last year.

New Industry for Scotland.

The Weaver Manufacturing Company, of America, makers of garage and service equipment, is a well-known concern. It is reported that the home and Empire market is to be catered for by a British Weaver Manufacturing Company, Ltd., with a factory and registered office in the West of Scotland. The head offices and warehouses are to be in London.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

The Coal Trade.

Shipments last week were rather better than in the preceding week, inasmuch as the total came to 359,730 tons, as compared with 328,815 tons, but when set against the figures for the corresponding period of last year, there was a substantial reduction, as the quantity of coals and coke shipped was then 439,448 tons. The only ports which did not show an improvement were Newport and Swansea. For once in a way the loading pressure at Swansea was easier as the returns show that on Saturday last there were six idle tips, while at the other ports vacant loading berths numbered forty. Arrivals of tonnage over the week-end resulted in the loading position being better though not to any appreciable extent at Swansea. At the other ports, however, the number of idle tips was reduced to twenty-six. Conditions in the steam coal trade have been showing signs of trade expanding, though it should be pointed out that an improvement is generally looked for round about this time of the year. All the leading undertakings appear to have more orders on their books for fairly early shipment. Still, the position of individual collieries is far from satisfactory, as will be seen from the fact that as a precautionary measure miners have been given fourteen days' notices to terminate their contracts at one well-known concern, while at a leading colliery producing the best Admiralty coal, about 1000 men have been given similar notices. Although official details are not yet known, it is reported that the output quota for the December quarter is to be reduced. It is stated that the Central Council allocations are based on a 5 per cent. reduction on the outputs in the corresponding period of last year. At present the permitted production is about 66 per cent. of the standard figure of 12,985,470 tons. So far there has been no fresh development as regards business between this district and the Irish Free State, but returns show that for the five weeks ended the 2nd inst., total shipments from this area to the Irish Free State were only 18,716 tons, as compared with 53,392 tons for the previous five weeks before the 5s. duty was imposed by the Irish Free State Government. Quite a number of vessels have lately been chartered to load German and Polish coals for Ireland, and there is good authority for saying that in one case a contract has been entered into for the supply of 20,000 tons of German and Polish coals for delivery over a period of twelve months. This is the largest single contract so far recorded in Continental coals for Ireland, and the business has been carried through by a Cardiff firm of coal exporters.

New Coalowners' Association.

Reference was made a short time ago to the report of the formation of a new association of colliery undertakings producing steam and bituminous coals in this area, the purpose being to prevent under-selling and to co-ordinate production. At the end of last week an official announcement on the subject was forthcoming, though the details disclosed do not throw much new light on the question. The official statement says that the formation of an association amongst collieries in South Wales is an accomplished fact under the title of the Associated Welsh Mines. The Association has as its objects co-operation and co-ordination in the production and sale of the outputs of the companies in order to secure for South Wales its full share of the world's trade. The groups involved are producers of about 75 per cent. of the steam and bituminous coals raised. Much care and thought will be given to the production of coal in the necessary quantities and in the most economic way. With regard to sale, there exist great possibilities of economies within the various organisations. There is no intention of disturbing the harmonious relations that have existed between the various collieries and the exporting mediums they have employed in the past, nor is there any intention of following either a system that was once in being in America in merging coals that had similar characteristics under the designation of "pools," or the system now in being in Germany, where the consumer purchases a coal under a general name. It is intended to adhere strictly to the system of declaring by certificates the actual collieries from which the coal purchased has been raised. The Associated Welsh Mines will not trade as an association. The individual groups of collieries will continue to trade exactly as heretofore, under their own names and sell their own production in a general sense very much as in the past, but it is their expressed intention to continue to improve their products and, as far as may be practical, bearing in mind the international difficulties at present existing, to recover to South Wales as much as may be possible of the trade that has been lost.

Small Coals for Fuel Making.

Colliery owners in July last made a special concession to the patent fuel makers in this area by agreeing to supply them with small and duff for fuel making at half the f.o.b. shipment price. Last week the Executive Council of the Marketing Association decided to withdraw this concession, which has been taken advantage of by the fuel makers, and to revert to the old arrangement of permitting a reduction up to 2s. 6d. per ton in respect of fresh wrought coal, and up to 3s. 6d. for banked smalls on the minimum prices, in order to enable the fuel manufacturers to compete with Continental makers.

French Tonnage in Coal Trade.

In view of the report a week ago of the proposal of the French Government to adopt measures at the end of this month by which half of the coals imported into France shall be carried in French steamers, it is interesting to find that, according to the returns for the month of July 5026 vessels of 5,657,000 net tons sailed from the United Kingdom with cargoes of coal, of which 3318, of 3,931,000 net tons were British. The remaining 1708, of 1,726,000 net tons, carried foreign flags, of which 243, of 249,000 net tons, were French. A considerable proportion of the French tonnage sailing from the United Kingdom ports is employed in the coal trade to France, but the bulk of the British tonnage is engaged in the long-distance trade.

Cardiff's Facilities.

A deputation from the Cardiff Trades and Labour Council attended the meeting of the Cardiff City Council on Monday, and made allegations concerning the action of the Great Western Railway Company in regard to the coal-loading facilities at the Bute Docks, Cardiff. The gist of the complaint was that the company was not adhering to its pledge to the Corporation to hold the balance of trade equally between the ports by reducing the number of appliances. Enforced economies were larger at Cardiff than at the adjoining ports, and the trend appeared to be to make Cardiff more an import port than an export port. The Lord Mayor stated that he had written to the general manager calling attention to the allegations, and in reply Sir James Milne said that it was correct that certain of the coal-shipping appliances at Cardiff East Dock had recently been taken out of commission. The company regretted the necessity for the adoption of this course, but the fact was that for some time past the shipping facilities at Cardiff had been, and were still, far in excess of the requirements. He assured the Lord Mayor, however, that there was no substance in the suggestion that any action of the company had caused the diversion of traffic from Cardiff to other ports, as the company had no control over the placing of shipment orders and the taking out of appliances and the dismissal of men had followed the falling off of shipments. The City Council, however, decided to appoint a special committee with plenary powers to take immediate steps to investigate the whole position with a view to sending a deputation to Paddington as soon as possible.

Traffic Returns.

Statistics issued by the Great Western Railway Company, relating to the trade at the six ports in South Wales under their control, show that for the four weeks ended August 28th, imports and exports totalled 1,765,321 tons, as compared with 2,016,512 tons for the corresponding period of last year. Exports at 1,509,537 tons were the lowest recorded this year, and compared with 1,841,910 tons for the four preceding weeks. From the beginning of this year to August 28th imports and exports combined amounted to 17,208,712 tons, which compares with 18,422,165 tons for the same period of 1931.

Tenders for Plant.

At the end of last week the Swansea Corporation Electricity Committee considered tenders for plant for the super power station now being constructed at Tir John North. In a report on tenders for the switchgear-house for the new station, the consulting engineers recommended acceptance of the tender of Griffith Davies and Co., Swansea, of £8813 9s. 8d., this being the lowest, and with one exception giving the shortest period for completion. Fourteen tenders from seven firms were received for the steam-raising plant, including pulverisers and four boilers for the station. These were referred to the consulting engineers for tabulation and report. Tenders for turbines were also referred to a sub-committee for report.

Current Business.

Although operations on the steam coal market were a shade better, the tone generally was still quiet. The inquiry for large coals was substantially below the requirements of the collieries, most of which had big stocks. Sized descriptions were in good demand and rather scarce. Patent fuel was quieter, but coke moved off rather more freely. Pitwood was on the dull side, with prices ranging from 19s. 9d. to 20s. 6d.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

Mr. Adam Hunter, M. Inst. C.E., has resigned, on account of ill-health, from the board of Sir William Arrol and Co., Ltd., but will retain the position of consulting engineer to the firm.

Dr. Harold Moore, C.B.E., who has for many years been Director of Metallurgical Research at the Research Department, Woolwich, has been appointed, as from October 1st, 1932, Director of the Metals Research Association to succeed Dr. R. S. Hutton, who has been elected to the new Goldsmiths Professorship of Metallurgy at Cambridge University.

Mr. Henry Ashman Reed, a member of the Council of the Institution of Civil Engineers, and consulting engineer to the Manchester Ship Canal Company, has recently been appointed a representative of Great Britain on the Permanent International Commission of Navigation Congresses, and British representative on the International Committee in connection with the Permanent International Commission of Navigation Congresses which has been formed to prepare a technical dictionary in several languages of the engineering words and phrases used in connection with the sea, rivers and canals, maritime and river works, docks, harbours, &c., and their design, construction, and maintenance.

CONTRACTS.

The Chemical and Insulating Company, Ltd., of Darlington, has secured the orders for the heat insulation on H.M.S.'s "Achilles," "Leander," "Diana" and "Delight."

The Pulsometer Engineering Company, Ltd., of London and Reading, has received an order for the two 10-ton fire and bilge pumps for the four new sloops—H.M.S. "Falmouth," "Weston-super-Mare," and "Milford," and one for H.M.S. Dundee."

The Cape Asbestos Company, Ltd., has just secured one of the largest lagging contracts ever placed in this country, in connection with the new super-electric power station at Barking. The "Caposite" lagging which will be used is manufactured entirely from Amosite asbestos produced from the company's mines in the Transvaal, South Africa.

The Professional Engineer.—Steps are being taken in the United States to found an Engineers' Council for Professional Development with the following objects:—"First, to develop further means for the educational and vocational orientation of young men with respect to the responsibilities and opportunities of engineers, in order that only those may seek entrance to the profession who have the high quality, aptitude, and capacity which are required of its members; secondly, to formulate criteria for colleges of engineering, which will ensure to their graduates a sound educational background for practising the engineering profession; thirdly, to develop a programme for the further personal and professional development of young engineering graduates and a programme for those without formal scholastic training; fourthly, to develop methods whereby those engineers who have met suitable standards may receive corresponding professional recognition."

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
(1) Native	16/6 to 20/-
(1) Spanish	17/- to 22/6
N.E. COAST—	
Native	18/- to 21/-
Foreign (c.i.f.)	14/6

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	3 7 6	—
No. 1 Foundry	3 10 0	—
No. 3 Foundry	3 7 6	—
N.E. COAST—		
Hematite Mixed Nos.	3 0 0	3 0 0
No. 1	3 0 6	3 0 6
Cleveland—		
No. 1	3 1 0	3 1 0
Siliceous Iron	3 1 0	3 1 0
No. 3 G.M.B.	2 18 6	2 18 6
No. 4 Foundry	2 17 6	2 17 6
No. 4 Forge	2 17 0	2 17 0
Mottled	2 16 6	2 16 6
White	2 16 6	2 16 6
MIDLANDS—		
(c) Staffs.—	(*Delivered to Station*).	
All-mine (Cold Blast)	—	—
North Staffs. Forge	3 1 0	—
„ „ Foundry	3 6 0	—
(c) Northampton—		
Foundry No. 3	3 2 6	—
Forge	2 17 6	—
(c) Derbyshire—		
No. 3 Foundry	3 6 0	—
Forge	3 1 0	—
(3) Lincolnshire—		
No. 3 Foundry	—	—
No. 4 Forge	—	—
Basic	—	—
(4) N.W. COAST—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	3 15 6(a); 4 0 6(b); 4 5 6(c)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	9 15 0	9 5 0
Best	—	—
N.E. COAST—		
Iron Rivets	11 5 0	—
Common Bars	9 5 0	—
Best Bars	10 5 0	—
Double Best Bars	10 15 0	—
Treble Best Bars	11 5 0	—
LANCS.—		
Crown Bars	9 15 0	—
Best Bars	10 5 0	—
Hoops	12 0 0	—
S. YORKS.—		
Crown Bars	9 15 0	—
Best Bars	10 15 0	—
Hoops	12 0 0	—
MIDLANDS—		
Crown Bars	9 0 0 to 9 15 0	—
Marked Bars (Staffs.)	12 0 0	—
Nut and Bolt Bars	8 0 0 to 8 10 0	—
Gas Tube Strip	10 10 0	—

STEEL. (*d*)

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates (Marine)	9 0 0	8 10 0
„ „ (Land)	—	—
Ship Plates, ½in. and up	8 15 0	7 15 0
Sections	8 7 6	7 7 6
Steel Sheets, ¼in.	7 15 0	7 15 0
Sheets (Gal. Cor. 24 B.G.)	11 0 0	9 10 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	8 15 0	7 15 0
Angles	8 7 6	7 7 6
Boiler Plates (Marine)	10 10 0	—
„ „ (Land)	10 0 0	—
Joists	8 15 0	7 7 6
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5s.
Hard Billets	7 2 6	—
Soft Billets	5 10 0	—
N.W. COAST—		
BARROW—		
Heavy Rails	8 5 0	—
Light Rails	8 10 0 to 8 15 0	—
Billets	6 10 0 to 9 0 0	—
MANCHESTER—		
Bars (Round)	9 7 6	—
„ (Small Round)	6 15 0 to 7 0 0	—
Hoops (Baling)	10 0 0	9 15 0
„ (Soft Steel)	9 0 0	8 15 0
Plates	8 17 6 to 9 2 6	—
„ (Lancs. Boiler)	8 10 0 to 8 12 6	—
SHEFFIELD—		
Siemens Acid Billets	9 2 6 (basis)	—
Hard Basic	8 2 6 and 8 12 6	—
Intermediate Basic	6 12 6 and 7 2 6	—
Soft Basic	5 15 0	—
Hoops	9 10 0 to 9 15 0	—
Soft Wire Rods	7 10 0	—
MIDLANDS—		
Small Rolled Bars (all British)	7 0 0 to 7 5 0	—
Small Re-rolled Bars	6 7 6 to 6 10 0	—
Billets and Sheet Bars	4 17 6 to 5 7 6	—
Galv. Sheets, f.o.b. L'pool	9 7 6 to 9 10 0	—
(2) Staffordshire Hoops	9 10 0	—
(*d*) Angles	8 7 6	—
(*d*) Joists	8 15 0	—
(*d*) Tees	9 7 6	—
(*d*) Bridge and Tank Plates	8 17 6	—
Boiler Plates	8 7 6 to 8 10 0	—

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14 f.o.b.	15/3 to 15/9
Block Tin (cash)	147 10 0
„ (three months)	149 0 0
Copper (cash)	31 10 0
„ (three months)	31 10 0
Spanish Lead (cash)	12 6 3
„ „ (three months)	12 16 3
Spelter (cash)	15 0 0
„ (three months)	15 3 9
MANCHESTER—	
Copper, Best Selected Ingots	36 0 0
„ Electrolytic	37 10 0
„ Strong Sheets	68 0 0
„ Tubes (Basis Price), lb.	0 0 10½
Brass Tubes (Basis Price), lb.	0 0 9½
„ Condenser, lb.	0 0 11½
Lead, English	14 15 0
„ Foreign	13 2 6
Spelter	15 5 0
Aluminium (per ton—raw ingot)	£95

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	2/- per lb.	
Ferro Tungsten	1/9 per lb.	
Ferro Chrome, 4 p.c to 6 p.c. carbon	£25 0 0	8/-
„ „ 6 p.c. to 8 p.c.	£24 10 0	7/6
„ „ 8 p.c. to 10 p.c.	£23 5 0	7/-
„ „ Specially Refined		
„ „ Max. 2 p.c. carbon	£37 0 0	11/-
„ „ „ 1 p.c. carbon	£44 10 0	14/-
„ „ „ 0·70 p.c. carbon	£46 0 0	16/-
„ „ „ carbon free	1/1 per lb.	
Metallic Chromium	2/9 per lb.	
Ferro Manganese (per ton)	£10 15 0 for home	
„ „ „	£9 15 0 for export	
„ Silicon, 45 p.c. to 50 p.c.	£13 10 0 scale 5/- per unit	
„ „ 75 p.c.	£19 0 0 scale 6/- per unit	
„ Vanadium	12/6 per lb.	
„ Molybdenum	6/3 per lb.	
„ Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£245 0 0	
Ferro Cobalt	7/9 per lb.	

FUELS.

SCOTLAND.

	Export.
LANARKSHIRE—	
(f.o.b. Glasgow)—Steam	13/-
„ „ Ell	14/-
„ „ Splint	13/9 to 14/9
„ „ Trebles	13/- to 13/6
„ „ Doubles	11/6
„ „ Singles	10/-
AYRSHIRE—	
(f.o.b. Ports)—Steam	11/6
„ „ Jewel	16/6
„ „ Trebles	13/6
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—Steam	10/3 to 12/6
Screened Navigation	16/6
Trebles	14/6 to 15/6
Doubles	12/-
Singles	10/-
LOTHIANS—	
(f.o.b. Leith)—Best Steam	11/- to 11/6
Secondary Steam	10/6
Trebles	14/-
Doubles	11/6
Singles	9/9 to 10/-

(8) N.W. COAST— ENGLAND.

Steams	21/-
Household	32/6 to 52/6
Coke	19/- to 22/6
NORTHUMBERLAND—	
Best Steams	13/6
Second Steams	12/3 to 12/6
Steam Smalls	9/6
Unscreened	12/6 to 13/-
Household	27/- to 39/-
DURHAM—	
Best Gas	14/6
Second	13/3 to 13/6
Household	25/- to 37/-
Foundry Coke	24/-

SHEFFIELD—	Inland.	
Best Hand-picked Branch	27/- to 28/-	—
South Yorkshire Best	22/- to 24/-	—
Derbyshire Best House	22/- to 23/6	—
Derbyshire Best Brights	18/- to 20/-	—
Screened House Coal	17/- to 18/6	—
Kitchen Coal	16/- to 17/6	—
Best Screened Nuts	16/- to 17/6	—
Small Screened Nuts	15/- to 16/6	—
Yorkshire Hards	17/- to 18/-	—
Derbyshire Hards	17/- to 18/-	—
Rough Slacks	8/6 to 9/6	—
Nutty Slacks	7/- to 8/6	—
Blast-furnace Coke (Inland)	9/6 to 9/9 on rail at ovens	
Furnace and Foundry Coke (Export), f.o.b., 14/6 to 15/6		

(9) SOUTH WALES.

CARDIFF—	
Steam Coals:	
Best Smokeless Large	19/6 to 19/9
Second Smokeless Large	18/9 to 19/6
Best Dry Large	19/- to 19/6
Ordinary Dry Large	17/9 to 18/3
Best Black Vein Large	18/3 to 18/6
Western Valley Large	17/9 to 18/-
Best Eastern Valley Large	17/7½ to 17/9
Ordinary Eastern Valley Large	17/3 to 17/6
Best Steam Smalls	13/- to 13/6
Ordinary Smalls	11/- to 13/-
Washed Nuts	19/- to 25/-
No. 3 Rhondda Large	19/6 to 19/9
„ „ Smalls	15/- to 16/-
No. 2 „ Large	17/- to 17/3
„ „ Through	15/6 to 16/-
„ „ Smalls	14/- to 14/3
Foundry Coke (Export)	22/6 to 36/6
Furnace Coke (Export)	17/- to 18/-
Patent Fuel	20/-
Pitwood (ex ship)	19/6 to 20/6
SWANSEA—	
Anthracite Coals:	
Best Big Vein Large	36/- to 38/6
Seconds	27/- to 32/6
Red Vein	22/6 to 27/6
Machine-made Cobbles	41/6 to 48/6
Nuts	40/- to 48/6
Beans	28/6 to 32/6
Peas	19/6 to 21/-
Breaker Duff	8/6 to 9/6
Rubbly Culm	11/- to 11/6
Steam Coals:	
Large	20/- to 20/6
Seconds	18/- to 20/-
Smalls	11/6 to 13/-
Cargo Through	16/- to 17/6

(1) Delivered. (2) Net Makers' Works. (3) f.o.b. Makers' Works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire. (6) Home Prices—All delivered Glasgow Station. (7) Export Prices—*f.o.b.* Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. (a) Delivered Glasgow. (b) Delivered Sheffield. (c) Delivered Birmingham. (*d*) Rebate: Joists (minimum), 22/6: Ordinary Ship, Bridge, and Tank Plates and Sections, 15/- if home consumers confine purchases from associated British Steel Makers. (e) Delivered Black Country Stations.

French Engineering Notes.

(From our own Correspondent in Paris.)

Commercial Treaties.

In preparation for the trade agreements which have been rendered necessary by the general economic dislocation the Chambers of Commerce and other organisations are offering their views upon the policy that should guide the Government in negotiating new treaties. The principle upon which the French tariffs are based has always been to fix a minimum scale in such a way that the cost of goods delivered into the country free of duty and transport charges should not be less than the cost of similar goods manufactured in France. A much higher general tariff of a more elastic character is provided for negotiating with countries that do not enjoy the most-favoured-nation treatment. It is now practically decided that the most-favoured-nation clause must be abandoned. The principle of placing foreign goods on an equality of cost with the French has not worked out as it should have done in practice, and the arbitrary methods of appreciating costs, and the addition of taxes either for fiscal reasons or for giving satisfaction to home producers, have made it increasingly difficult for importers to do business in this country at all. Nevertheless, the system would not be without merit if these arbitrary methods were suppressed, and a strict observance of the principle of the tariff system is recommended by the Lille Chamber of Commerce, which urges that the Government should take advantage of such preferential tariffs to ensure that each country shall purchase goods or produce from France of equal value to what it sends here. This is the first time that such a policy has been advocated in this country. The dogma of a favourable balance of trade has had to be abandoned in view of the rapidly increasing discrepancy in exchanges during the past few years, and the object now is to make sure that there can be no adverse balance, while even that result is regarded as difficult of attainment unless the heavy social charges and taxes imposed on industry are reduced. The idea of complete reciprocity is so general that the fear of its being upset by the negotiations with the United States' delegates has induced industrial and commercial associations to make strong representations to the Government to hold firm to the necessity of equal concessions. The United States can make no concessions on its rigid tariff, but there is a threat of a 50 per cent. increase in the duties on French goods entering the States unless France accords to America the most-favoured-nation treatment. The French are anxious to abandon all most-favoured-nation treatment and to adhere strictly to the principle of reciprocity. Therefore the Government is being urged to suspend negotiations with the United States.

The Cavaillon Suspension Bridge.

The new suspension bridge across the Rhône between Cavaillon (Vaucluse) and Plan-d'Orgon (Bouches-du-Rhône) was officially opened last week by the Minister of Public Works. Its length of 304 m. makes it the longest suspension bridge in France. It replaces an old bridge with pylons in the river that was considered unsafe for modern traffic and, moreover, would offer an obstruction to the development of the river traffic which is to follow upon the carrying out of the scheme for improving navigation between Marseilles and Lyons and ultimately to Basle. The two pylons on the banks are 42 m. high and the metallic platform 8 m. wide is supported by cables each 10 cm. in diameter and weighing altogether 500 tons. The bridge was constructed by the Compagnie Fives-Lille.

International Traffic.

The carrying out of works for improving navigation on the Rhône is attracting attention in Italy, where it is feared that Genoa, which was formerly the chief port of transit to Switzerland and the south of Germany, will suffer from a permanent diversion of traffic. Notwithstanding the costly improvements made to the port of Genoa, the decline of traffic has been accentuated since 1929 in a way that is not to be explained entirely by the general depression, and as the declension is far less marked in the case of Marseilles it is concluded that more of the traffic is diverted through France. The Rhône navigation scheme is therefore a serious matter for the Italians. Their chief difficulty lies in being unable to obtain special rates from the Swiss railways, which appear reluctant to offer concessions that may prejudice the plans of Basle to become a great inland port, and it is obvious that when Basle can deal with traffic not only to the North Sea, but also with the Mediterranean by way of the Rhône, there will be little chance of Genoa regaining its former supremacy. Nevertheless, the Rhône scheme is still a long way from realisation, and the Italians are preparing to make the most of their short direct route from the Mediterranean to Central Europe, by instituting a permanent organising commission in Switzerland, while a plan has been suggested for constructing a motor road from Genoa to Zurich so that goods can be sent by road.

Solar Illumination.

References have been made in these notes to a system of reflecting the sun's rays throughout the interiors of buildings which has been tested in Paris for some time past by the inventor, Monsieur J. Arthuys, who has made a number of installations, including one in a newspaper building. Recently he described his system before the Société des Ingénieurs Civils. An arrangement of mirrors and lenses whereby a vertical beam from the roof can be deflected to the ceilings of any number of rooms offers, of course, no difficulty, but the mobile mirror moving with the sun must be automatic and require no attention, for which reason anything in the way of clockwork is out of the question. The mirror is moved by the sun's heat, which expands a gas and raises a column of mercury to make contact for an electric motor. When the mirror faces the sun another thermic cell breaks the contact, and these movements continue intermittently to keep the mirror in the sun's path. There is no doubt that on occasions when the sun does actually shine the arrangement is effective and can be made to flood the whole of the inside of a building from top to cellar. The system was heralded as marking a new departure in the art of illumination, but as the amount of sunshine is essentially variable in these latitudes it is probable that the system will be left to find its own applications.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

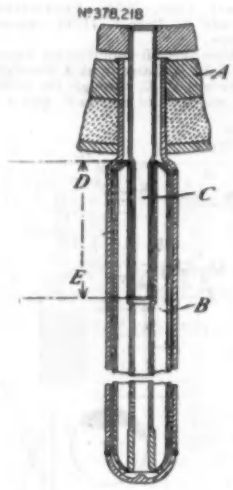
The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

STEAM GENERATORS.

378,218. August 27th, 1931.—MERCURY VAPOUR BOILERS, *The British Thomson-Houston Company, Ltd., Crown House, Aldwych, London, W.C.2.*

We index this invention under steam generators, but it is really concerned with the generation of mercury vapour for power purposes. The tubes of the boiler are of the Field type and are welded into the drum A. Within each of them there is an empty filler B, to economise the amount of mercury within

Nº 378,218



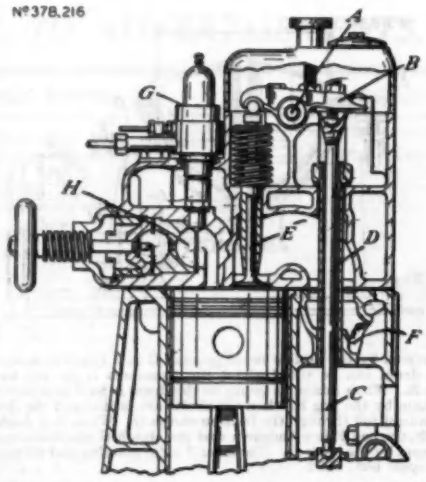
the boiler. The inner, circulating tube C, which carries the liquid mercury to the bottom of the generating tube, does not extend to the whole length, but is continued by a passage through the filler. There is no actual contact between the tube C and the filler, so that either may expand under the influence of heat, but a gas-tight joint is made between the two parts by the height of the column of liquid mercury between D and E.—*August 11th*, 1932.

INTERNAL COMBUSTION ENGINES.

378,216. August 26th, 1931.—THE INTERCONVERSION OF SIDE VALVE AND OVERHEAD VALVE ENGINES, R. A. Lister and Co., Ltd., and A. F. Sanders, Long-street, Dursley, Gloucestershire.

This invention relates to the conversion of side valve spark-ignited internal combustion engines to overhead valve engines of the compression ignition type, with the minimum of alterations. As will be seen from the drawing, a new cylinder head is provided with an overhead shaft A carrying a rocker B operated

Nº 378,216



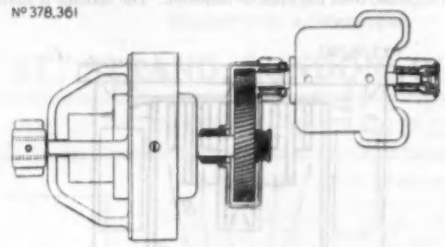
by a push rod C which passes through a sleeve D that takes the place of the side valve guide. The valve E is worked by the rocker arm. The valve passage F is aligned with that in the cylinder block which was previously used for the side valve. The cylinder head furthermore carries the fuel injection valve G and a two-part ante-chamber H, one part of which communicates tangentially with the main combustion space. The design of cylinder head is such as to give the desired clearance for the compression necessary for operation on the compression ignition principle.—*August 11th*, 1932.

TURBINE MACHINERY.

378,361. April 5th, 1932.—GEARED TURBINES. *G. R. Shepherd, 2, Norfolk-street, Strand, London, W.C.2.*

The object of this invention is stated to be a reduction in the overall dimensions of geared turbo-generators. In the place of the usual double-helical gearing there is a set of single-helical gearing, with the wheels overhung on the ends of the shafts, so that the space occupied by outboard bearings is saved. The end thrust in the shafts caused by the helical gearing is taken care

Nº 378,361



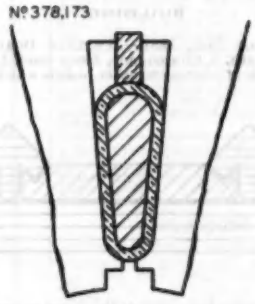
of by thrust blocks and the steam pressure in the turbine.—*August 11th*, 1932.

DYNAMOS AND MOTORS.

378,173. July 13th, 1931.—THE WINDINGS OF DYNAMOS, Siemens-Schuckertwerke, Aktiengesellschaft, Berlin-Siemensstadt, Germany.

This invention is concerned with the intimate contact of the insulated conductors of generator rotors with the core iron, failing which a glow effect is liable to be produced that will

Nº 378,173



damage the insulation. As a consequence the slots for the conductors are made tapered with the bottom wider than the part towards the periphery. They are also deeper than the radial dimension of the conductor. The conductor is easily slipped in place in the larger part of the slot and is then wedged outward into tight contact with the core. The space left at the root of the slot is utilised for ventilation.—*August 11th*, 1932.

378,287. November 28th, 1931.—COMPOUND-WOUND MOTORS FOR ELECTRIC TRACTION WITH REGENERATIVE BRAKING, L. Bacqueyrisse, 53 ter Quai des Grandes Augustines, Paris (Seine), France.

This invention concerns a method of series parallel control of compound-wound motors, the shunt fields of which are arranged to be connected in series, for electric traction with regenerative braking. It consists, on the one hand, in the transition from series to parallel during starting, in eliminating a certain number of motors (for example, a half in the case of motors of an even number) after reduction of their counter electromotive force, for example, by elimination of their shunt excitation and short-circuiting their armatures and series fields by suitable resistances, then in connecting the armatures and series fields of the eliminated motors to the full voltage of the supply after establishing between their terminals a tension approximately equal to that of the supply, for example, by reason of a preliminary

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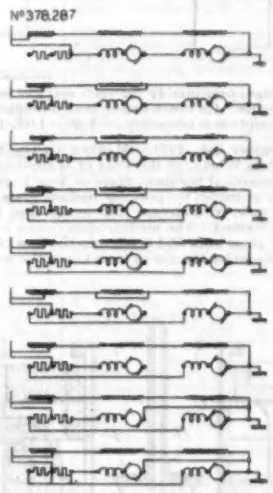

adjustment of their shunt excitation; and, on the other hand, in the transition from parallel to series during regenerative braking in short-circuiting the armatures and series fields of the same motors acting as generators by suitable resistances, after disconnecting them from the supply and reducing their electromotive force, for example, by elimination of their shunt excitation, then in arranging the eliminated motors acting as generators in series with the motors acting as generators remaining in circuit and in re-establishing their electromotive force, for example, by the placing in circuit of their shunt excitation, with the object of obtaining a permanent traction effort at the time of the starting and a permanent resistant effort during regenerative braking, to prevent the working as generators of one or more motors during the starting and the working as motors of one or more generators, during the regenerative braking, with a minimum of resistance losses. The diagrams show the changes in the connections for an installation of two motors.—*August 11th*, 1932.

TRANSFORMERS AND CONVERTERS.

378,293. December 2nd, 1931.—METALLIC VAPOUR RECTIFIERS, Siemens-Schuckertwerke Aktiengesellschaft, Berlin-Siemensstadt, Germany.

According to this invention, there is provided a cooling device for a metallic vapour rectifier in which the cooling surfaces are

so arranged that the distance between adjacent surfaces decreases progressively whilst the total effective area of cooling increases progressively as the distance (in the normal direction of flow of the vapours) from the cathode increases. The cathode is shown

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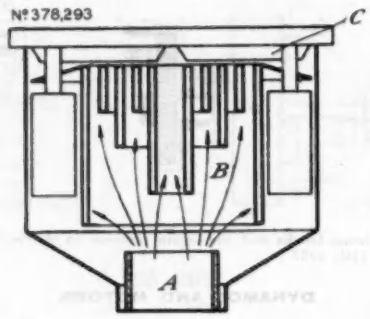


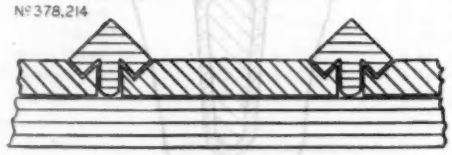
at A and the cooling cylinders at B. The graduation in their length provides the desired result. The cover is also furnished with ribs C, which conduct the condensed mercury to the sides of the vessel, where it is further cooled.—*August* 11*th*, 1932.

BUILDING.

378,214. August 25th, 1931.—WEATHER BOARDING JOINTS, T. Duckworth, 3, Church-lane, Essex-road, London, N.1.

A simple form of jointing weather boards which possesses the

Nº 378,214



advantages that the full width of the board is preserved while a good "shed" for moisture is provided.—*August* 11*th*, 1932.

MISCELLANEOUS.

378,274. November 6th, 1931.—HINGES, Kap Société Anonyme 6, Rue Jean-Jaurès, Puteaux (Seine), France.

This hinge is intended for doors, or frames which are hung

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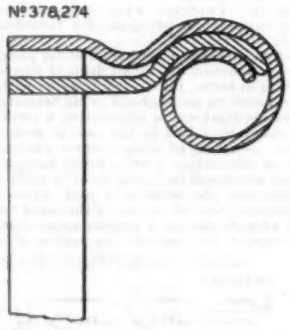

from the top edge, presumably for such services as greenhouse lights and skylights. Its construction is so obvious in the drawing that no description is necessary.—*August* 11*th*, 1932.

378,291. December 1st, 1931.—MAKING GLASS TUBING, The Corning Glass Works, at the Foot of Walnut-street, City of Corning, County of Steuben, State of New York.

Glass tubing is made by pouring molten glass through an orifice, over a weir, in a stream sufficiently thin to prevent a solid rod being formed. The molten glass comes from the forehearth A of the glass tank and is fed into the bowl B in a steady stream. It flows under the sleeve C and over the weir or curb D

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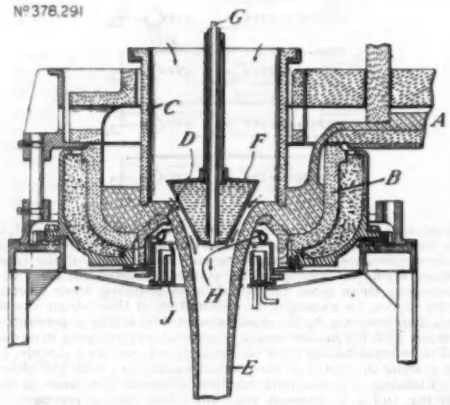

to form the tube E. There is a conical cooling plug F through which water is circulated, while a blast of cold air is blown down the tube G. At H there is a ring burner, which may be used to heat the emerging glass, and at J there is a water-jacketed cooler. The interior surface of the glass tube is not touched by any forming mechanism while the exterior is smoothed out by the burner H, so that a highly finished tube is produced.—*August* 11*th*, 1932.

378,352. March 15th, 1932.—PAINT CONDITIONING MACHINES, The Glidden Company, 11,001, Madison-avenue, Cleveland, Ohio.

This machine is intended for mixing paint which has been stored in cans for a long time and has settled out. It comprises a horizontal shaft A, which is oscillated by the crank B and connecting-rod C. On either end of the shaft A there is a

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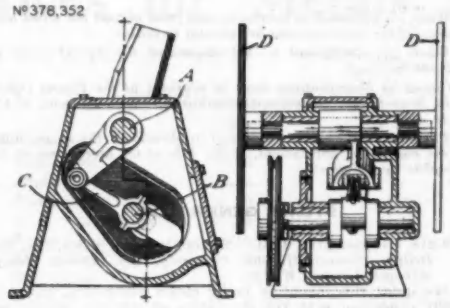

removable chucking piece D to which the cans of paint are attached by clamps. The rocking action thoroughly mixes up the paint.—*August* 11*th*, 1932.

378,801. February 22nd, 1932.—VENTILATING APPARATUS, J. Marshall and N. Turner, 11/33, Cogan-street, Pollokshaws, Glasgow.

It is claimed that this air-conditioning apparatus is exceptionally compact. Air is drawn in at A through a preheater B, past the water sprays C, C, through the baffle plates D—to eliminate surplus water—into the fan E, and is delivered down-

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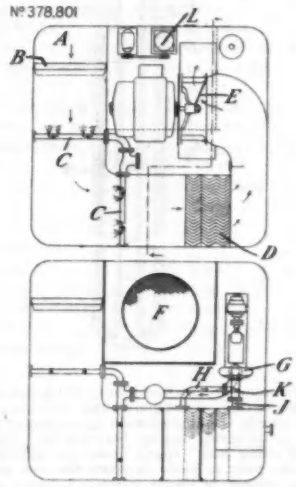

wards through a second heater F. In the outlet there is a thermostat. The water supply to the sprays C is provided by the pump G, and is derived either from a hot water main H, or a cold main J through a three-way valve K. This valve is operated by a servomotor, which is supplied by the air compressor L and is controlled by the thermostat.—*August* 18*th*, 1932.

378,841. May 12th, 1932.—MIXING AND STIRRING MACHINES, A. Henkel, Windsor House, Victoria-street, London, S.W.1.

This is a mixing machine for such purposes as making sweetmeats, and has a tiltable drum. In such machines, as generally made, it is necessary to remove the stirrer before the drum can be tilted, as it is operated from above. In this machine the contents can be tilted out with the mixer in place, as it is operated from below. The stirring arms A and B are rotated in opposite

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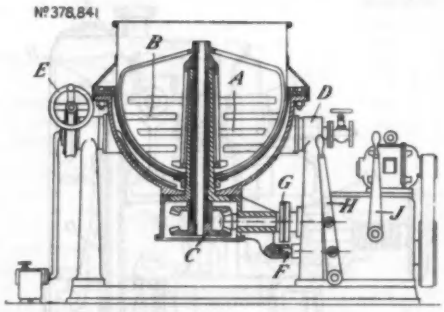

directions by the double bevel gearing C in a familiar manner. The drum can be tilted about the trunnions D by the hand gear E. When mixing is going on the drum is held in a vertical position by the peg F, when the shafts are in line and the drive is transmitted through the friction clutch G. When it is desired to tilt, the peg F is withdrawn and the clutch G simultaneously released by the lever H. The lever J is for starting and stopping —*August* 18*th*, 1932.

378,197. July 30th, 1931.—COMPOUNDING RUBBER, The Goodyear Tyre and Rubber Company, 1144, East Market-street, Akron, County of Summit, and State of Ohio, United States of America.

This invention relates to methods of compounding rubber stocks and it has particular relation to methods of compounding stocks suitable for tread units for pneumatic tires and similar articles. The object is to provide a stock which is more highly resistant to abrasive wear than stocks prepared by methods which have heretofore been employed. In order to produce a stock of this character it is common practice to incorporate into the rubber certain ingredients, notably carbon black and zinc oxide, which impart toughness and hardness to the vulcanised product. Since ordinary unvulcanised rubber, particularly when it contains considerable quantities of pigments, becomes relatively stiff, it is necessary to incorporate along with the pigments certain oils or plasticisers which tend to soften the stock and render it more workable. Heretofore it has been customary simultaneously to effect the addition of these plasticising agents and the pigments employed in the stock. This invention comprises the discovery that material improvements in the durability of the above-described pigment-loaded stocks, such as are employed in the manufacture of tread units for pneumatic tires, may be effected by introducing the plasticising agent into the rubber prior to the addition of the carbon black or other pigments. After the plasticisers are incorporated in the rubber and the preferred reinforcing agents homogeneously mixed therewith, the remaining compounding ingredients, such as sulphur, accelerators, fillers, other pigments, other plasticisers, additional rubber, and the like, may be incorporated. The essential feature is to mix a plasticiser with the rubber before the preferred pigments, generally reinforcing pigments, are added. A plurality of plasticisers may be mixed in the rubber before the reinforcing pigments are incorporated or, if desired, some of the plasticisers may be added along with the remaining compounding ingredients. This addition of the plasticising agent may be effected by first incorporating in the rubber the oleaginous material employed as a plasticiser, after which the other ingredients of the stock may be added. However, in actual practice it is preferable to manufacture what is termed a "master batch" which contains a relatively small percentage of rubber and relatively high percentage of plasticising agent and pigment. The following is an example of a master batch, the use of which has been found by experience to give excellent results:—Rubber, 55 parts by weight; pine tar, 5 parts by weight; gas black, 40 parts by weight. The pine tar is incorporated in the rubber prior to the incorporation of the gas black. In the above formula it is desirable to add a small amount of carbon black in excess of the figure actually named in order to compensate for losses due to dissemination of the black as dust in the atmosphere. This stock may be added to substantially any rubber compound in which it may be desirable to incorporate a carbon black. An excellent material for the preparation of tread units for pneumatic tires may be prepared by adding quantities of this master stock to the tread unit stock in such proportions that the ultimate material comprises the following formula:—Rubber, 61·06 parts; zinc oxide, 3·40 parts; carbon black, 26·42 parts; sulphur, 1·70 parts; stearic acid, 2·48 parts; pine tar, 3·52 parts; phenyl beta naphthylamine, 0·60 parts; mercaptobenzothiazole, 0·82 parts. In this formula 66 parts of the master batch are employed in order to obtain the desired proportions of pine tar and carbon black.—*August* 11*th*, 1932.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Tuesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY TO SATURDAY, SEPTEMBER 17TH.

INTERNATIONAL FOUNDRY CONGRESS.—Paris.

TO-DAY TO MONDAY, SEPTEMBER 19TH.

INSTITUTION OF MECHANICAL ENGINEERS.—Summer visit to Canada.

TO-DAY TO WEDNESDAY, SEPTEMBER 28TH.

BUILDING EXHIBITION.—Olympia. 11 a.m. to 9 p.m. daily.

SATURDAY, SEPTEMBER 17TH.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—North-Eastern District meeting. Visit to Roman Wall, Northumberland. Assemble at George Inn, Chollerford. 11 a.m.

WEDNESDAY, SEPTEMBER 21ST.

INSTITUTION OF CIVIL ENGINEERS: YORKSHIRE ASSOCIATION.—Visit to the B.B.C. North Regional Station. 3 p.m.

THURSDAY, SEPTEMBER 22ND.

OPTICAL SOCIETY.—At the Imperial College of Science and Technology, Imperial Institute-road, South Kensington, S.W.7. Special general meeting. 5.30 p.m.

FRIDAY, SEPTEMBER 23RD.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Midland District Meeting at Coventry. Assemble at Council House, Earl-street, Coventry. 2 p.m.

SATURDAY, SEPTEMBER 24TH.

ALL-BRITISH EXHIBITION.—Copenhagen, Denmark, Opening.

WEDNESDAY, SEPTEMBER 28TH.

BELFAST ASSOCIATION OF ENGINEERS.—Belfast. Inspection of new laundry, Poor Law Union. 7.30 p.m.

INSTITUTION OF WELDING ENGINEERS: NORTH-WESTERN BRANCH.—College of Technology, Sackville-street, Manchester. "Testing of Welds," by Mr. L. W. Schuster. 7.30 p.m.

SATURDAY, OCTOBER 1ST.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Visit to Kingsbridge and Salcombe Water Board's Works. Meet at South Brent Station, G.W. Railway. 2 p.m.

FRIDAY, OCTOBER 7TH.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, S.W.1. "Cornwall as a Cradle of Science and Engineering," by Mr. S. J. Crispin. 7.30 p.m.

FRIDAY, OCTOBER 14TH.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, S.W.1. Chairman's Address, Mr. J. Foster Petrie. 7.30 p.m.

BUSK STUDENTSHIP IN AERONAUTICS.—The trustees of this studentship, founded in memory of Edward Teshmaker Busk, who lost his life in 1914 whilst flying an experimental aeroplane, have awarded the studentship for the year 1932–33 to Mr. Herbert Brian Squire, of Balliol College, Oxford.

THE INSTITUTION OF ELECTRICAL ENGINEERS.—"The Students' Quarterly Journal," which appears in October, December, February, and April of each year, is issued free of charge to students and graduates under 28, but other members of any class may obtain it on payment of an annual subscription of 6s., which should be sent to the secretary of the Institution. The charge to non-members is 10s. per annum.

THE OLBO PIPE WRENCH.—A handy pipe wrench, which it is claimed will be found particularly useful in restricted spaces, has been produced by the Union Glue and Gelatine Company, Ltd., of Golden-lane, London, E.C.1. The loose jaw is held by a stirrup and ratchet from the fixed jaw, and it is claimed that this construction allows the wrench to be operated rapidly within a greatly reduced angle of action. Although designed specially for pipe work, it should also be suitable for nearly all the other purposes for which wrenches are used.